WATER WORKS & SEWERAGE

A GILLETTE ABP ABC PUBLICATION

L. H. Enslow EDITOR

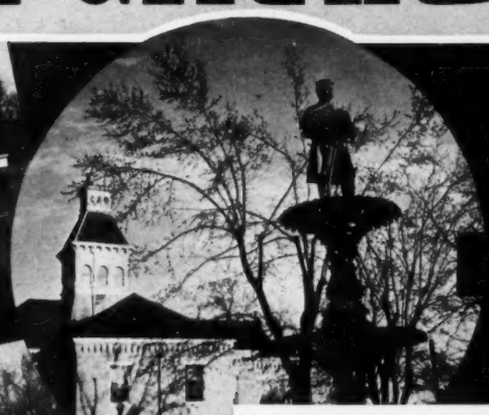
AUGUST, 1938
VOLUME 85, No. 8

in CAPE GIRARDEAU, Mo.

Cape Rock Water Works

Cape Rock Garden Adjacent to the Water Plant

State Teachers College Administration Building



Soldiers' Monument and the City Hall of Cape Girardeau

On the banks of the Mississippi, about half way between St. Louis and Memphis, stands Cape Girardeau, the city that has had the greatest population gain of any, whose population is over 10,000, in the State of Missouri. Not "just another one of those sleepy river towns", Cape Girardeau has a unique building construction record. During the past decade there has never been a year that did not bring at least 100 new buildings.

Cape Girardeau is referred to by the State Highway Commission as "Missouri's City Beautiful" and by commercial interests as the metropolis, the educational, cultural and industrial center of Southeast Missouri, the richest section of the state.

Numbered among its points of interest are a State Teachers College, listed as one of the five greatest schools of its kind in the United States; a large Catholic College; while Cape Girardeau's industries include a portland cement plant, large shoe, tobacco and electric appliance factories, lumber mills and an unusual publishing plant. The Chamber of Commerce has its own fine building, and in Cape Girardeau about every facility for good living conditions that could be desired, can be found, including a Utility Plant that services the city and several adjacent counties. In the 100% metered water system Pittsburgh Water Meters are measuring the consumer and industrial consumption accurately.

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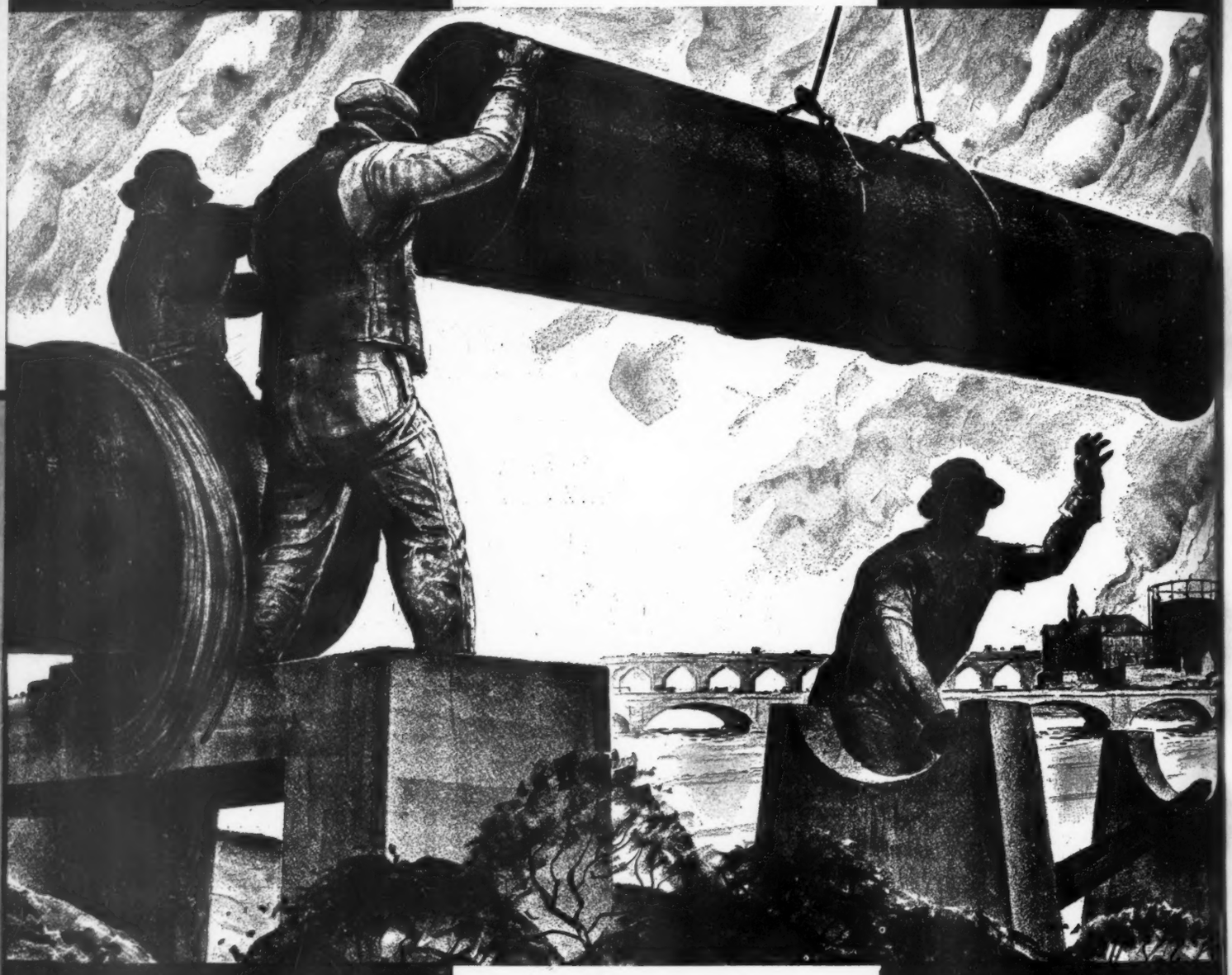

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ONE of the most outstanding research programs of the last decade was the five-year investigation of the causes and prevention of pipe-line corrosion conducted by the American Petroleum Institute and the American Gas Association in conjunction with the Bureau of Standards. The published reports of this survey prove that, for lasting protection, underground pipe must be wrapped with asbestos felts. Typical quotations from these reports are as follows:

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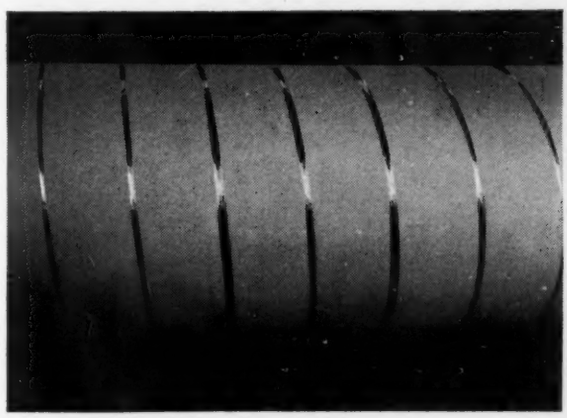

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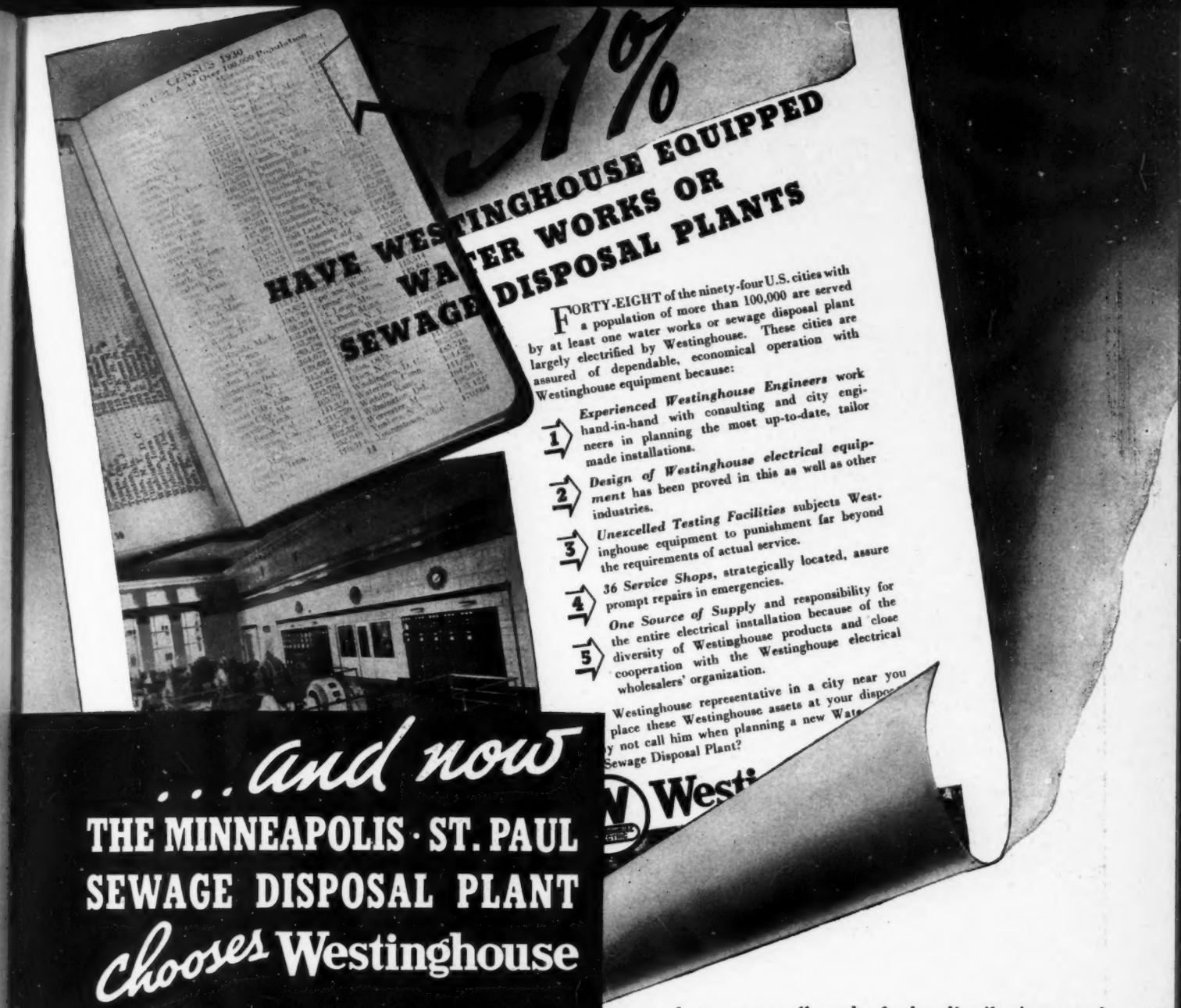
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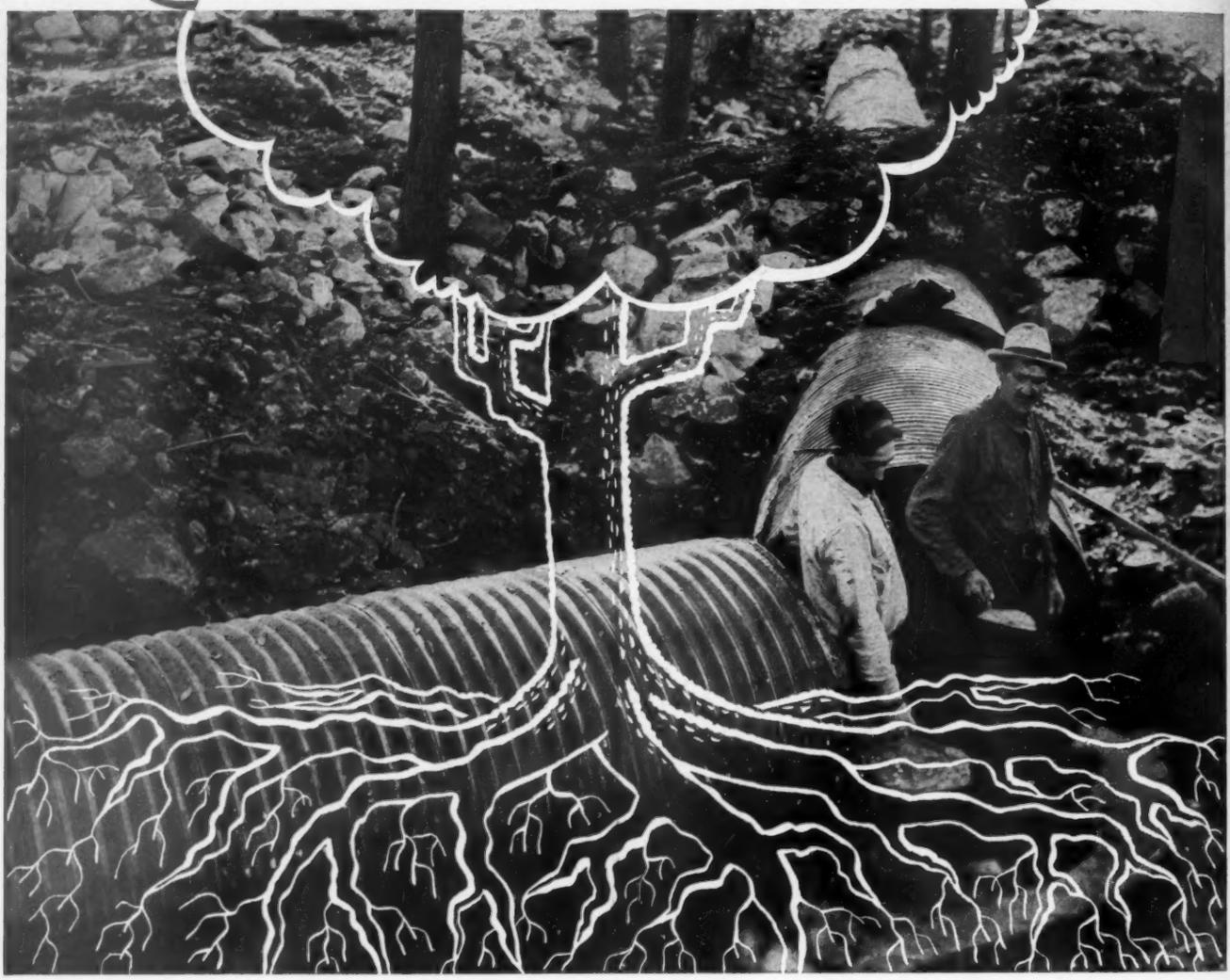

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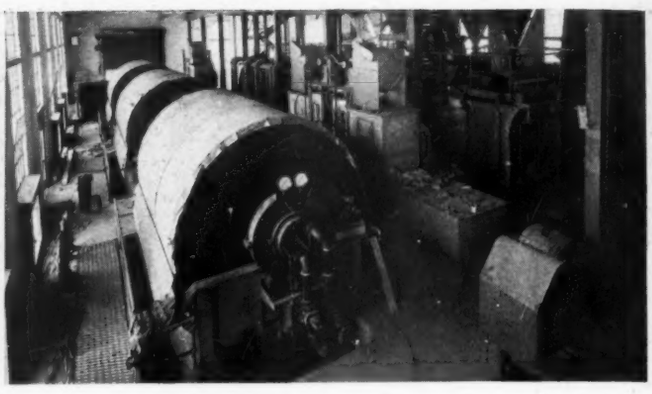

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A Magnetite Filter 4' wide on a 35' diameter tank and Conkey Filters 3' x 4' at

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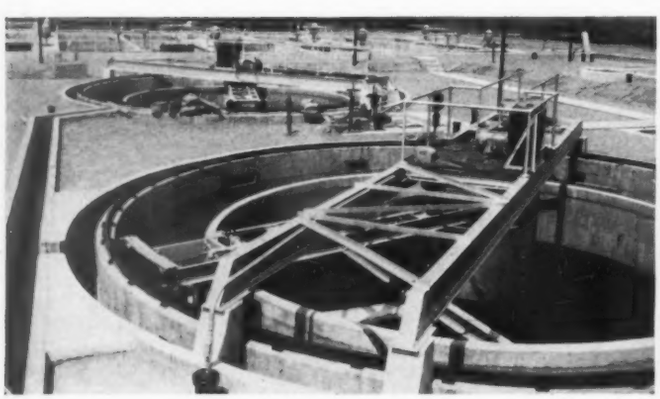

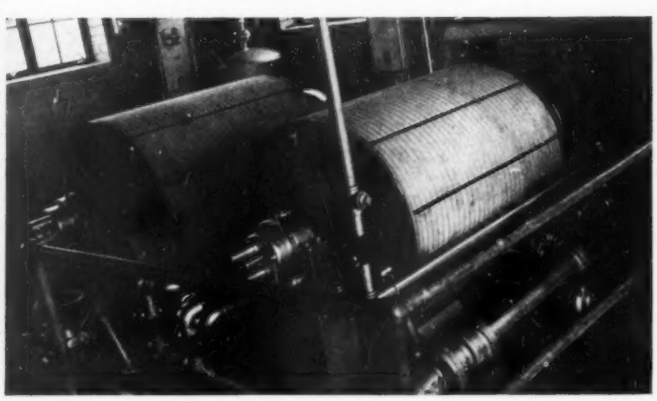

The 2 Magnetite Filters at Lakeland are 3' wide on 21' diameter tanks. The Conkey Filters as installed at Lakeland are available as single or duplicate filters mounted on single base with all auxiliaries.

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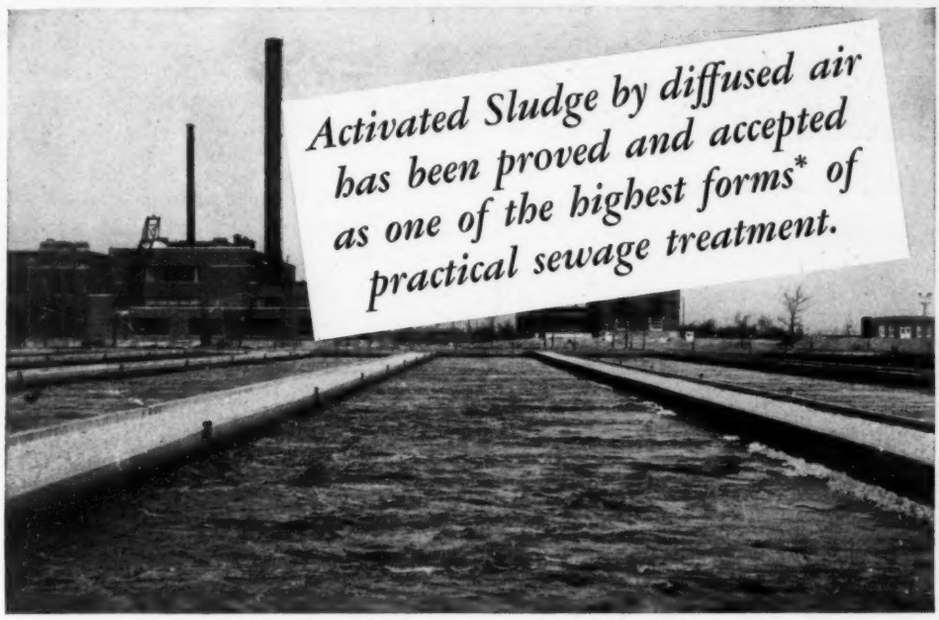
FORCEFUL FACTS ON SEWAGE AERATION BY AIR DIFFUSION—No. 17


Activated Sludge by diffused air
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as one of the highest forms* of
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*Watch for Forceful Facts No. 18 for another form.

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Not the least of the problems at Winchester has been the proper sterilizing of new mains. Like hundreds of other water works men throughout the country, Mr. Sanderson uses HTH for this important job with "very satisfactory results".

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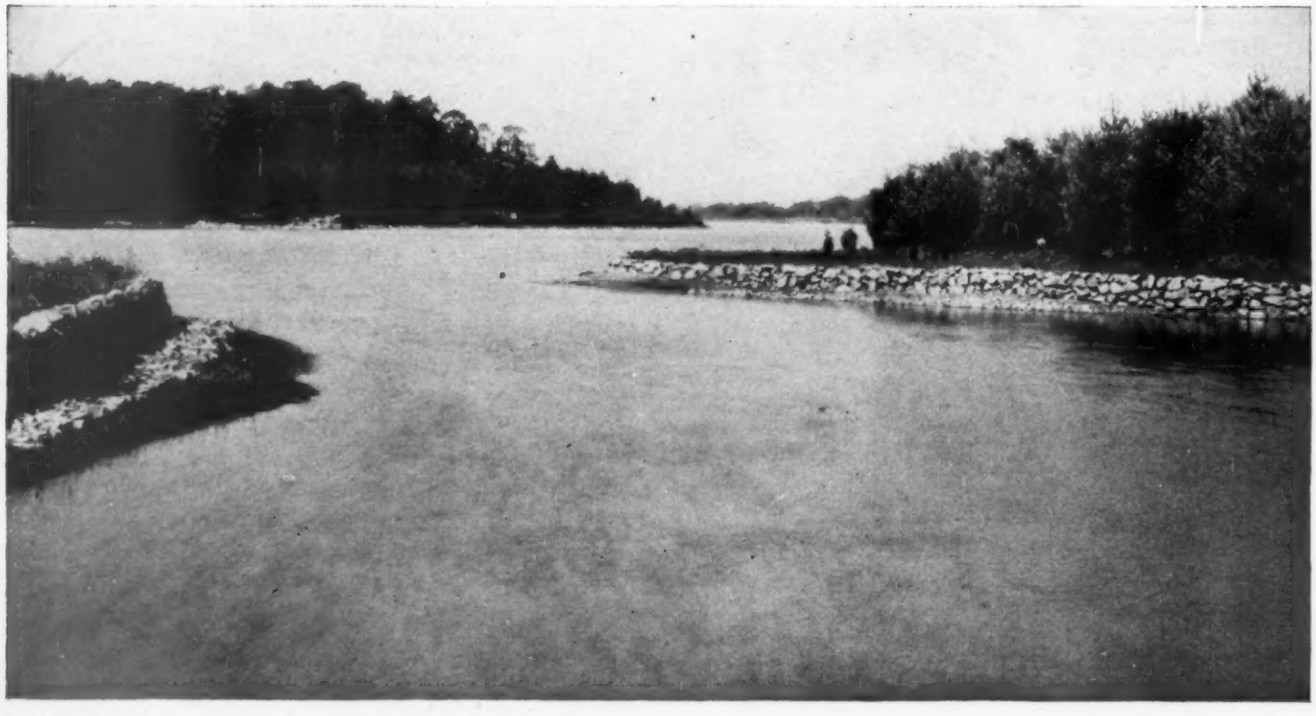

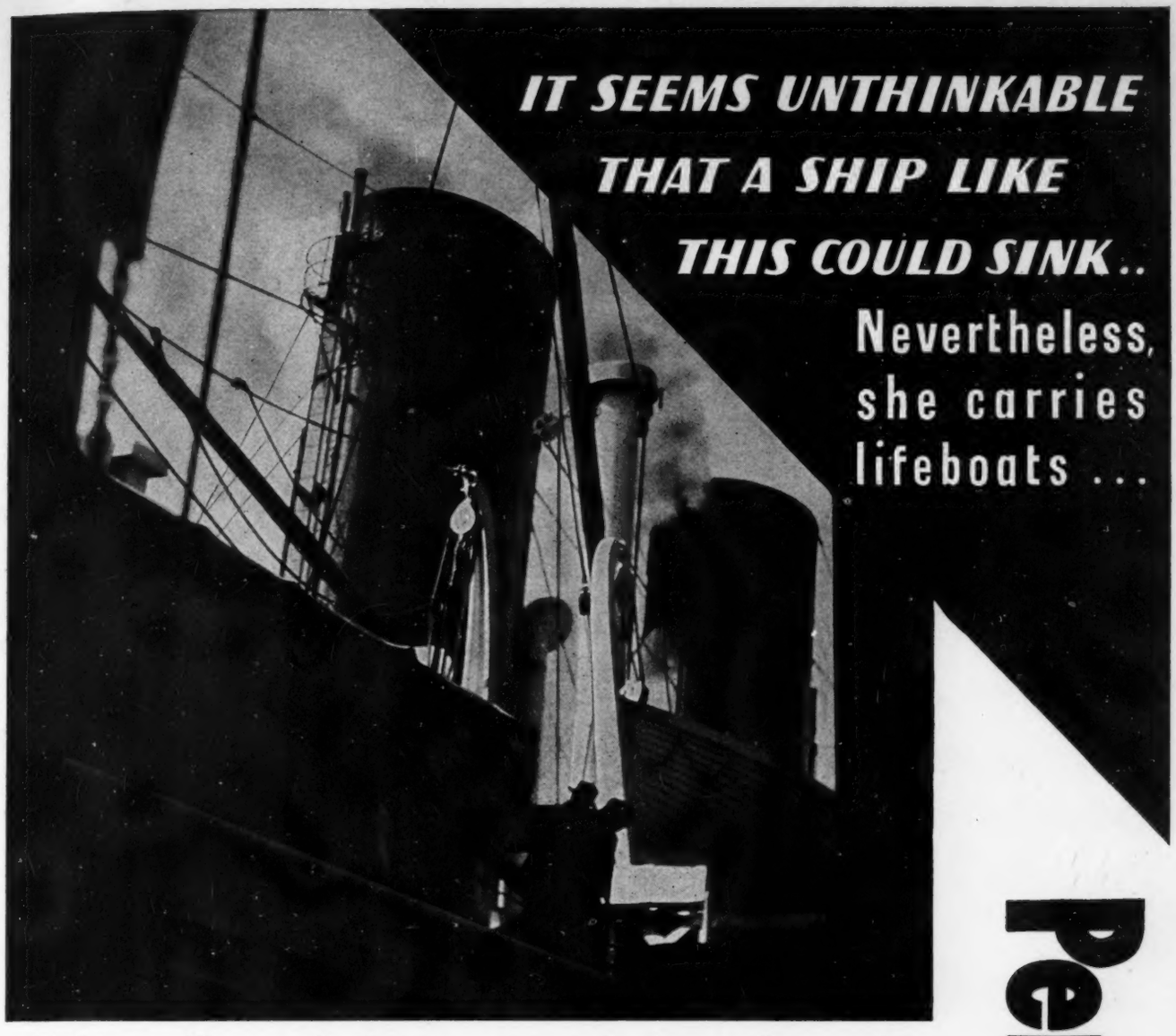

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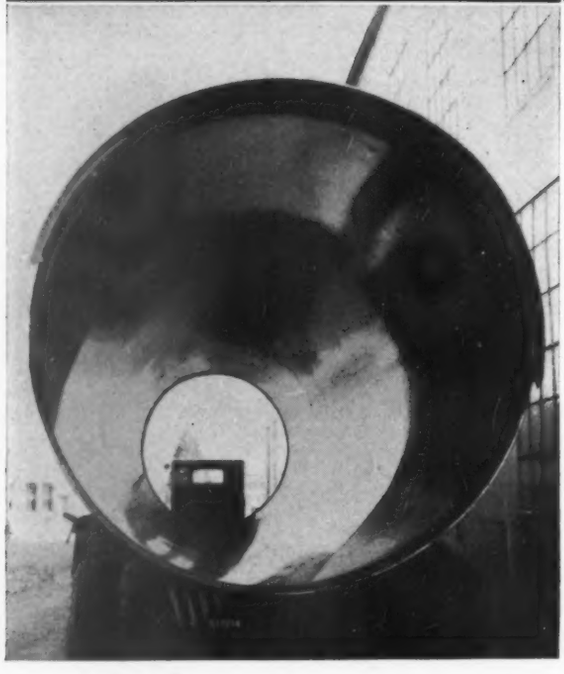

● Not only on major water works and pipe line transmission projects, such as those shown on this page, but on "everyday" pipe line and conduit installations throughout the country, REILLY PIPE ENAMEL and PRIMER are widely used for protection against corrosion, tuberculation and destructive agencies. REILLY ENAMEL provides a coating that resists abrasion and withstands a wide range of temperatures—from 200° F. to —20° F. It will not sag or flow at high temperatures, nor crack or chip at low temperatures. Easily and economically applied by all usual methods. For absolutely *dependable pipe line protection*, insist upon *Reilly Pipe Enamel and Primer*.

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WATER WORKS & SEWERAGE

E. S. GILLETTE, Publisher — L. H. ENSLOW, Editor

ARTICLES AND AUTHORS Scheduled for Future Issues

In this issue appears the first of two articles by ROBERT A. ALLTON, on the subject **"Financing Sewerage Through the Sewer Rental Plan."** The introductory paper describes and discusses four methods of making charges for sewer and sewage treatment service. In the article to follow, the author who is Consulting Engineer in the Division of Sewage Treatment of Columbus, Ohio discusses in more detail that which experience has shown to be important considerations incident to the development of an equitable and sound schedule of charges, and the important collection of such charges. The scheme adopted by the Columbus authorities involves billings based on metered water consumption, such billings and collections being made by the Water Department on an income participating basis. Considerations in arriving at the plan adopted in connection with industrial water users, and the method of charging for industrial sewage contributed by non-water takers, are of especial interest. The ordinance, framed by Mr. Allton, leaves little for interpretation and its language is such as to preclude loop-holes, "special considerations" or future arguments over charges to the industrial sewer user. The "sewage tight" ordinance of Columbus will prove a worthy guide to the many faced with sewerage financing in the modern and equitable manner. (Mr. Allton's contribution, promised readers much earlier, has been postponed at his suggestion pending appearance of the introductory paper which was presented before the American Water Works Association.—Ed.)

"Methods of Meeting Peak Water Demands," discussed by W. V. WEIR, Supt., St. Louis County Water Co., reveals three methods of taking care of troublesome and costly peak loadings on water works facilities. Mr. Weir, based on operating experiences, describes two methods of amplifying and operating a water system so as to supply peak demands, (created by air conditioning or sprinkling loads and the like), with the least cost of providing requisite facilities and minimum expense of operating schedules. In addition, he presents "a plan," involving establishment of special off peak rates, which has been inaugurated by the St. Louis County Water Company to the benefit of purveyor and consumer alike. Mr. Weir, deplores the fact that "there is probably no other industry with such a poor load factor as that of our industry (water supply), that has not done or genuinely tried to do something to improve it." Thereupon, he offers some worth while suggestions in the direction of promotion of water sales through off-peak schedules. This, for the dual purpose of holding down expansion costs and power demand charges, building good will; in addition, raising gross and net revenues. There's lots of meat in Mr. Weir's contribution, which, based on experience, offers the choice of "a plan" and two methods of solving the costly peak demand problem.

"Improvements to the Topeka, Kan., Sewage Treatment Works" with comments on operating results is the contribution of T. R. HASELTINE, who was connected with the design and tuning up of the revamped Topeka plant.

Vol. 85, No. 8

CONTENTS for AUGUST, 1938

Water Main Cleaning 753
By THOMAS B. RAY
Chief Engineer, Skowhegan, Maine

The Sewer Rental Method of Sewerage Financing 758
By ROBERT A. ALLTON
Consulting Engineer, Division of Sewage Treatment, Columbus, Ohio

Report of Penna. Sewage Works Ass'n Meeting 761

Glances at Recent Water Treatment Practice 771
By L. L. HEDGEPETH
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

Sewage Sludge Incineration 777
By E. T. KILLAM
Consulting Engineer, New York, N. Y.

A P.W.A. Project of George Washington's Time 782
By R. ALTON JACKSON
Winston-Salem, N. C.

Cathodic Protection 783
By STARR THAYER
Consulting Engineer, Houston, Texas

Activated Carbon Efficiency 786
By MARSDEN C. SMITH
Engineer of Water and Electricity, Richmond, Va.

Laboratory and Field Studies on Chlorine Demand of Sewage 789
By G. E. SYMONS, G. E. TERHOEVEN and W. L. TORREY
Respectively, Chief Chemist, Analyst, and Assistant Analyst, Buffalo Sewer Authority, Buffalo, N. Y.

Iron Pickling Wastes in Sewage 796
By CHARLES F. HAUCK
Junior Chemist, Southerly Sewage Treatment Works, Cleveland, Ohio

Disapproved Plumbing Fixtures 801
By ARTHUR B. CRONKRIGHT
New York, N. Y.

The Editor's Comments 804

Equipment News 806

With the Manufacturers 807

Meetings Scheduled 808

Catalogs and Literature Reviewed 809

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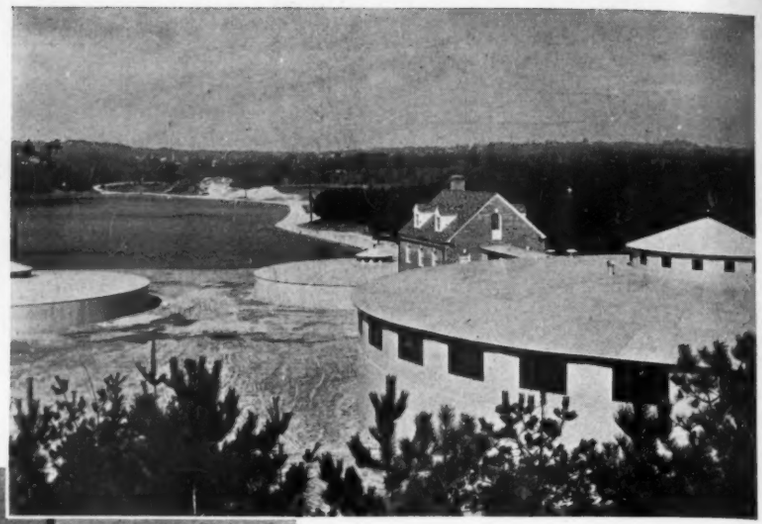

Above—Bristol's new Morse type filter plant. *Left*—Interior view looking across coagulating basin. *Below*—An aerial view showing intake crib at lower left, two 400,000 gal. filtered water storage tanks in center, pump house and filter plant in upper center, and two 25,000 wash water tanks in top right corner.

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Cleveland.....2262 Rockefeller Bldg.	Houston.....2919 Main Street	San Francisco.....1083 Rialto Bldg.
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Fabricating plants in CHICAGO, BIRMINGHAM, and GREENVILLE, PA.

WATER WORKS AND SEWERAGE
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WATER MAIN CLEANING

Some Experiences With the Mechanical and the Chemical Methods

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The Author

IN THE past several years, the attention of water works managers and engineers has been increasingly drawn to the problems caused by loss of capacity in pipe lines. The New England Water Works Association published in its Journal for September, 1935, an exhaustive account of the rate and type of corrosion and tuberculation, and the Main Water Utilities Association and the American Water Works Association have discussed at some length the significance and type of interior pipe coatings applied to delay or prevent tuberculation and consequent loss of capacity. A considerable amount of information is therefore available to the water works authorities planning new installations, but unfortunately, most of us are concerned in greater degree with systems as they now are, not as they should be. It is the purpose of this paper to report some actual experiences in cleaning mains to increase capacity, and to supply information concerning the methods, results secured, and cost of such cleaning.

The Skowhegan Job

Our first cleaning job, in order of time, was performed on the system of the Skowhegan Water Company, serving the town of Skowhegan, Maine. This system, in 1936, was nearly fifty years old, and contained an unusually large amount of 4-inch cast-iron pipe, used for fire protection as well as domestic service. The soft surface supply, with marked corrosive qualities, had caused marked main tuberculation. An investigation made prior to the cleaning work disclosed uniformly unsatisfactory hydrant flows from the 4 and 6-inch mains, and friction coefficients ranging from "C" values of 85 on the 10 and 8-inch mains, down to 40 on the 4-inch mains. Individual hydrant flow tests showed that there were seventeen hydrants out of a total of one hundred which produced less than one standard fire stream. This, with a standpipe full of water. Accordingly, it was decided to have the system cleaned mechanically, the work being carried on continuously from August 10 to September 23, 1936. The cleaning machines used were the standard type furnished by the National Water Main Cleaning Company, consisting of spring steel cutters attached radially to a central shaft or core. (See cut.) All of the 4-inch main, and some portions of the more heavily encrusted 6-inch main were cleaned by the "cable method," in which the cleaner is pulled through the pipe by means of a winch and cable. The balance of the 6-inch and all of the 8-inch mains were cleaned by the "pressure method," in which the cleaner is forced through the pipe by water pressure exerted on a piston at the rear of the cleaner.

Experiences with the Cable Method

In the cable method of cleaning, we found 800 feet to be the longest stretch of pipe which could be cleaned in one operation. However, inasmuch as most of the cleaning operations were between streets, we reduced most of the lengths to between 500 and 600 feet. At the start of operations, excavations are made at the beginning and end of the pipe to be cleaned. A section of pipe approximately four feet long is removed at each end, all services along the main are shut off, and the winch and cable drum is set up at the end of the

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Water-main cleaning is seemingly far too much a neglected practice. Why this betterment procedure is not more prevalently applied is not easily understood, especially so when one reads the enthusiastic comments of operators who have completed a main-cleaning project, and set forth the benefits effected.

It may be significant that water company officials are far more prevalently main-cleaning conscious than are municipal authorities, who may not weigh the economic gains so finely. Beyond reduced pumping costs, the author of this paper counts the gain to owners of insured properties, in rate reductions; and, the increased value of the system, based on its increase in carrying capacity, very nearly as much so as if the cleaned pipes had been renewed. There is a thought for owners of privately operated systems.

Cleaning of mains smaller than 4-inch size has always presented a problem, and Mr. Ray reveals an effective, economical and practical scheme of re-conditioning such pipe lines in place. This paper which recites experiences with the better known mechanical method, and the newer chemical cleaning procedure, is worthy of the position given it here.—Ed.

Set-up for Cleaning by Cable Method

section of main on the street level. A rubber cone with a small line attached is then floated through the pipe, a temporary connection being made at the first excavation. By means of this pull line, the steel pulling cable is drawn through the pipe, which is then ready for the insertion of the cleaner. When the cleaner has been forced into the pipe, the first cut is closed up by inserting a four-foot piece of pipe to replace the section removed. To speed up the work, we found it desirable in this operation to use mechanical couplings instead of poured joints. When the pipe has been sealed and the water turned on, the winch is operated, and the cleaner drawn through the pipe. The rate of speed depends largely on the condition of the interior of the main, but will average perhaps two or three feet per second. Full water pressure is applied to the pipe during cleaning, in order that the loosened material may be washed along ahead of the cleaner. At the end of the pipe, a 45 deg. bend and riser is attached so that the water and scale which flows out can be discharged into the street and thence to a sewer. (See cut.) At the completion of the operation, the cleaner is pulled out, the second cut patched up, and the services flushed to remove whatever foreign matter may have entered them.

This process sounds simple enough; but, it can become complicated on occasion. The cleaner itself is of rugged construction, capable of cutting through ordinary obstructions, but on several occasions in Skowhegan the cleaners became stuck due to encountering exceptionally large obstructions. On one occasion we removed from the inside of the pipe 35 lbs. of joint lead, in one lump. This lead had run in through a joint which had not been yarned in construction, and made a big enough lump so that the cleaner could not pass. In this instance the cable broke and snapped out of the open end of the pipe, so that the location and removal of the cleaner by digging down and cutting out another section of pipe, developed into a long and tiresome job. On other occasions we removed such unexpected obstacles as pieces of 2x4, stones, pump valves, and even an old pair of overalls.

The Pressure Method

The pressure method of cleaning entails much less equipment and less strong arm work. Of course the same excavations have to be made, but once the cleaner is inserted and the pressure turned on, one has only to follow the cleaner on top of the ground until it pops out of the riser at the end of the main. With a pressure of about 100 lbs. and a volume of about 500 g.p.m., the cleaner progresses about as fast as a man can walk. The noise made by scraping the pipe walls, and a slight vibration at the surface make it fairly easy to follow, except where the pipe is laid under deep cover. It is interesting to note that in the pressure method of cleaning, the cleaner will negotiate a 45 deg. bend with ease, so that it is possible to clean sections of main which have a large deflection.

Either of these methods of cleaning can be performed quickly and without trouble unless some obstruction is encountered. In addition to the objects mentioned above, hazards include partially closed gate valves, old fittings which are not shown on plans, and broken sections of pipe which have been repaired with sleeves or similar devices. Particularly on old systems, there is a probability that some of these difficulties will be encountered, so it is advisable to have on hand a supply of pipe cut to the proper length, repair couplings, and sufficient men to make the necessary excavations as quickly as possible.

Results

The results of the cleaning work in Skowhegan were quite satisfactory. Shortly after the completion of the work, the same flow tests, which had been made prior to the cleaning, were again carried out. The coefficients on the cleaned mains ran from a high of C=133 to a low of C = 105. On the 4-inch mains, which had exhibited the lowest coefficients before cleaning, one showed a value of 133, one 130, one 125, one 118 and one 110. The interior of these mains was found to be uniformly smooth and free from any sign of scale or tubercles. Of course the tar coating had also been removed, in this case of such heavy tuberculation.

The difference in coefficients can be attributed partly to the general conditions under which the mains had originally been installed, and partly to a difference in internal diameters. Adjustments were made for large differences in diameter, inasmuch as one pipe of nominal 4-inch diameter actually measured only 3⅝ inches. The lowest coefficient, 105, was on a 6-inch main. This main, however, was laid under difficult conditions, with several lateral and vertical deflections, and did not approximate a smooth straight condition. The 8-inch mains showed a coefficient of slightly greater than 120. Individual flows from hydrants showed a marked improvement (as the cuts indicate) over the former condition. All hydrants but one delivered at least one standard fire stream, and the one exception, located at the extreme end of the system, gave a flow of 210 g.p.m. Reviewing the results of the cleaning operation as a whole, it can be said that with the exception of hydrant branches, which were not cleaned, the mains were at

Close-up Showing Dirty Water and Debris Leaving Main. Later Shoveled Out of Street.

95 per cent of their original condition as far as carrying capacity is concerned. The improvement in fire protection was of course very great, and contributed in large measure to an improvement in the Underwriters Classification. Isolated tests since have indicated almost no loss of value in the coefficients of these mains, presumably due to the control of the corrosiveness of the water. In December, 1936, a new filtration plant was placed in operation, permitting control of pH and alkalinity so that the finished water can be maintained in an essentially non-corrosive state.

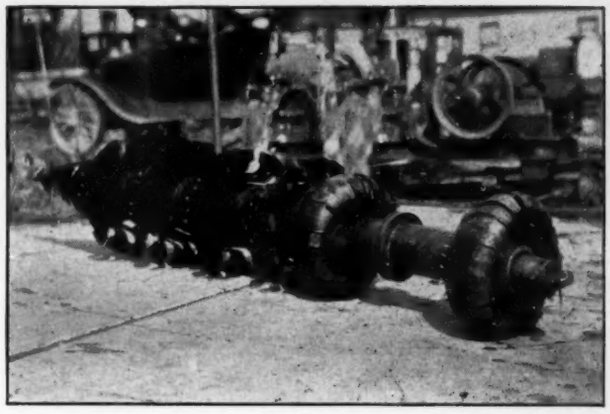
Costs

In this cleaning operation, a total of 42,266 feet of main was cleaned. This total comprises 4, 6, and 8-inch mains, with the bulk of the total divided between 4 and 6-inch mains. The total cost of the work, including engineering and supervision, labor, material, and rental of the cleaning equipment, was $5,200, a unit cost of 12.3 cents per foot. Although the mains cleaned were chiefly distribution, and hence did not greatly affect the pumping head, the improvement in consumer and fire service was considerable. In a review of the company's rates made in the same year, the Public Utilities Commission decided that a greater portion of the total revenue should be allocated to fire protection. It is safe to assume that the improved fire protection service, resulting from main cleaning, had some influence on this decision. There also occurs the question as to whether or not the increased capacity of the mains would have a favorable effect on the valuation of a system. Where capacity as well as structural condition of the pipe is given proper weight, in determining the condition of a system, it seems to us that an expenditure for cleaning mains becomes an investment as well as a betterment.

The Southwest Harbor Job

A more recent mechanical main cleaning job was undertaken in May of 1938 on the transmission main of the Southwest Harbor Water Company, at Southwest Harbor, Maine. This company serves a small community where the peak water demand occurs in the three summer months. During these months, the consumption increases to about three times the average demand for the balance of the year. Between the pumping station and the distribution grid, there is 7,100 feet of 6-inch main, which in the course of some 35 years had become heavily incrusted. The capacity of this line so limited the production of water that during the peak season, it was necessary to operate the pumps from twenty to twenty-four hours a day, and even then it was difficult to maintain an adequate reserve of water in the standpipe. Pitometer tests on this 6-inch main indicated a coefficient of 57 at a flow of 178 g.p.m., which was the maximum delivery of the larger of two electric driven centrifugal pumps. The friction head alone on this line was 70 lbs., necessitating an operating pressure of over 150 lbs. against a full standpipe head.

This main was cleaned by the pressure method during the week of May 3, 1938, the actual cleaning requiring two days. The cleaner was inserted a short distance outside the pumping station, and progressed for about 4,500 feet, where it was stopped. Most of this main being laid in a wooded and swampy area it was difficult to cover it on foot. Unfortunately, the cleaner got ahead of the two men following it, so that when it stopped its exact location was unknown. That was a predicament to be in. There followed an anxious period during which three excavations had to be made before the cleaner was finally located and removed. When the



The Pressure Method Cleaning Machine. Note the Scraping Blades Ahead of the Twin Propelling Pistons at the Rear.

cleaner stopped, a water hammer was developed in the main. It split two lengths of pipe. These lengths had to be removed and replaced before pressure could be applied to the line. During this time it had been impossible to pump, and the water level in the standpipe was dropping rapidly. However, fortunately the cleaner was located and removed before the stored water was exhausted. On the following day the standpipe was filled again before starting any further cleaning. After a short run the cleaner stopped a second time; but, this time, was located and removed in a fairly short time. Both of these stoppages were caused by unlooked-for obstructions in the pipe, chiefly in the form of large stones. After completing the interrupted run through the pipe, the cleaner was put through a second time. Much to our pleasure, it traveled the entire distance in twenty-five minutes without any mishap. The condition of the pipe after the second cleaning was extremely smooth and absolutely free from any deposit.

Results

Pitometer tests between two gauging stations, 6,400 feet apart, showed a total friction loss of only 38 feet at a flow of 250 g.p.m., or a coefficient of approximately C = 130. This reduction in head caused an increase in pumping capacity of 90,000 g.p.d. More important, it allowed the pump to operate at a much more efficient point on its characteristic curve. Before cleaning, this pump consumed power at the rate of 2.04 k.w.h. per m.g.; and, afterward, at the rate of 1.70 k.w.h. per m.g. Translated into dollars, this difference in power consumption represents, for an average year, a reduction in pumping cost of $270. In addition to this financial benefit, the increased capacity relieves the pumps of twenty-four hour duty and makes available a much greater supply of water for emergency uses.

Costs

On this job, the total length of main cleaned was 6,963 feet—the total cost $800, an average of 11.5 cents per foot. If the same coefficient can be maintained, the cost of the cleaning work will be amortized in three and one-half years from the saving in pumping costs. Experiments are now under way to determine a treatment which will retard further corrosion of this main.

Experience with Chemical Cleaning

A cleaning job of entirely different character was performed on a main of the Stockton Springs Water Company, at Stockton Springs, Maine, last month. A run of 1-inch galvanized steel pipe 575 feet long was

Chemical Main Cleaning Set-Up
One of the Acid Surge Tanks, Carboys of "Hydro-Artgel" Solution and Some of the Scale Removed

cleaned by the Hydro-Artgel Process of the Devonshire-Arctic Chemical Co. of Boston.

The chemical used is a commercial grade of acid to which has been added an inhibitor which prevents the acid from attacking any ferrous or cuprous metal while it is dissolving or loosening the scale and tubercules. The acid, mixed with a predetermined amount of water, is placed in the pipe and surged back and forth until all the scale and tubercles within the pipe are loosened, disintegrated or dissolved. The acid solution is then drained off, and a neutralizing solution of lime or soda ash added until the pipe interior is restored to its previous condition of pH value. The pipe cleaned at Stockton Springs was on an extremity of the system, connected to a 6-inch main. It was so filled with corrosion products that adequate service to all of the customers was impossible. It had been decided to replace this pipe with copper tubing when the Hydro-Artgel cleaning process was brought to our attention. Inasmuch as the pipe walls appeared to be sound, it was decided to first try the chemical cleaning. An excavation was made at the beginning and end of the 1-inch line, and a third in the middle, so that a section 18 inches long could be removed for inspection during the process of cleaning. An ordinary steel tank of about fifty gallons capacity was set up at each end of the line, to serve as surge tanks. Each was connected to the pipe by means of hose lines. (See cut.) A 105-lb. air compressor was set up midway between the two surge tanks, with a hose running to each tank. Enough chemical solution was introduced to fill the pipe. Then, by means of application of 80 lbs. air pressure to alternate ends, the liquid was surged back and forth through the pipe into the surge tanks, which acted as reservoirs. After the first few surges, it became apparent that the liquid was not traveling the full length of the pipe, and upon trying to blow the liquid out of the pipe into an open tank, it was discovered that the pipe was plugged in two places. Meantime an examination of the removable section showed no cleaning effect. However, the foaming of the acid, which had been removed from the pipe, indicated that a chemical reaction was taking place at points reached by the surging acid. By applying air and water pressure alternately to each half of the pipe line, the obstructions were finally blown out.

Results

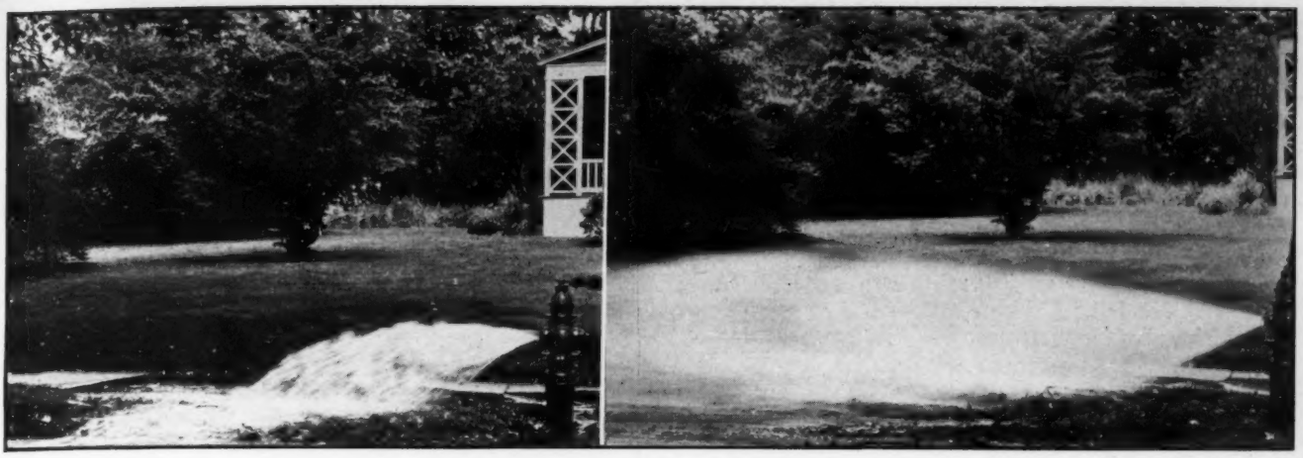
Up to this point, the results had been rather discouraging, as the pipe line had plugged up every time the acid or water was applied under pressure. On the following morning, the line was flushed with water under pressure, blown out with air, and seemed to be clear, although the flow of water had not increased appreciably over the original condition. A fresh mixture of acid and water was introduced, and the surging process repeated. After about four hours of effective surging, an inspection of the removable section, and also the two ends, indicated that no scale remained. When a flow test was tried, it was found that the pipe delivered twenty gallons per minute at the lower end, nearly the theoretical maximum under the pressure existing on the 6-inch main.

The line was then filled with hydrated lime solution, which was surged back and forth about four times. After flushing with water, the pH was found to be normal, and the job was considered finished. However, when the services were turned on, it was found that three of them were plugged with the scale which had been loosened from the pipe, and it was necessary to blow these out with air pressure to remove the accumulated loose particles. We considered the result quite satisfactory, as the flow had been increased from about six gallons per minute to twenty, which was sufficient to render adequate service to the limited number of customers on the line. The pipe showed a smooth bright interior similar to new pipe, with faint pit markings where large tubercles had been removed. There was no indication that the pipe itself had been attacked by the chemical. At the measured flow, the friction loss through the pipe corresponded to that shown for "smooth straight new pipe" in the Williams and Hazen tables.

Some Opinions

The method adopted for this particular job is not recommended for the cleaning of small pipes. While the chemical did an excellent cleaning job, the method of application was such as to make plugging of the pipe almost unavoidable as soon as a small quantity of scale had been loosened. Probably a better method would be to pass the chemical in *one direction only* until a large part of the scale has been loosened, removing it by straining from the solution before returning the acid to

Some of the Less Soluble Scale Taken from One of the Acid Surge Tanks.



A Picture the Fire Underwriters Like to See
One Hydrant; Two Flows—370 g.p.m. Before; 920 g.p.m. After Cleaning of Main

the line. A surge treatment at this point would then be effective, without the danger of having the pipe plugged. It is probable that in a larger diameter pipe (say 2-inch) this plugging would not have occurred. Of course, the larger the pipe, the less would be the possibility of such plugging. It also seems certain that some amount of scale will collect in the service pipes, from the main to the shut-off cock, during the cleaning operation. These pipes being dead ends, it is impossible to remove this accumulation by flushing the main. When pressure is turned on and the services opened, there is a strong probability that some of the scale will collect at reducing fittings or elbows inside the house plumbing. It is therefore recommended that these services be blown out and opened by means of air pressure applied in the cellar, thus forcing any deposit back into the main, where it can be flushed out of an open end. This operation could be performed after the neutralizing solution had been introduced, and prior to the final flushing of the main with water.

Costs

Unfortunately, no representative cost data can be inferred from the actual cost of this work at Stockton Springs. The job was largely in the nature of an experiment, with the chemical being supplied at a special price, and equipment such as the air compressor and pumps being loaned by other companies in the Northeastern group. However, the cost of the chemical alone, at regular prices for 1-inch pipe, would have been 3½ cents per foot, according to quotations from the Devonshire-Arctic Chemical Co., of Boston, as suppliers of the material. The surge tanks and an acid resistant chemical pump can be rented from the same company; or, if the amount of work justifies the investment, can be furnished by the water works plant. The tanks are ordinary steel tanks and the hose ordinary hose. The main requirement is a satisfactory acid-proof pump. In either case, it seems reasonable to assume that a job similar to the one described could be chemically cleaned for a unit cost not exceeding 10 cents per foot.

Conclusion

Our experiences indicate the following general conclusions about main cleaning: First, that tar coated cast-iron pipes of 4 to 8-inch diameter can be effectively cleaned mechanically for a cost which ordinarily should not exceed 15 cents per foot.

Second, that coefficients ranging from C-110 to 125 can be expected from the cleaned pipe.

Third, that with proper chemical control, further incrustation in the cleaned pipes can be materially retarded if not completely prevented.

Fourth, that scale and tubercles can be effectively removed from ferrous metal pipes by use of inhibited acid such as "Hydro-Artgel" solution.

Some amplification of these conclusions is perhaps necessary. The cost of mechanical cleaning is dependent upon the extent, length and size of mains cleaned; more importantly, the number of unforeseen difficulties encountered. The resultant coefficients will of course depend upon the condition of the pipe as originally laid; it might be fairer to say that one could expect a coefficient approximating 90 per cent of the coefficient of the main when new.

It should also be brought out that while the chemical performance of "Hydro-Artgel" has been proved satisfactory, some study as to the means of application is required. It is recommended to prospective users of this or similar material that a careful individual study be made of each job contemplated, and a suitable method evolved for each. Experience with this method may be well worth the price it costs to obtain in the initial undertaking.

Main cleaning by either method can greatly improve fire protection and domestic service, can effect large savings in pumping costs by reducing friction heads, can increase the production capacity of individual pump units, and may increase the valuation of a given water system.

From our experience mechanical cleaning for the larger mains and chemical cleaning of the smaller mains and pipe lines seems a worthy combination for securing maximum benefits at minimum cost.

Acknowledgment: This paper was presented by the author before the Maine Water Utilities Association at North Anson, Maine, July 8, 1938, and has been released for publication by the Association.

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OUR ERROR

Our July issue carried a report of the meeting of the Florida Section of A.W.W.A. Therein it was stated that the 1939 meeting of this Section is to be held in Fort Myers; but, in this, it appears that we were in error. Word has come from Secretary Hoy of the Florida Section, stating that although Fort Myers put in a strong bid and will receive favorable consideration, the location of the 1939 meeting is yet to be decided by the executive committee, which has other invitations to consider.

THE SEWER RENTAL METHOD OF SEWERAGE FINANCING

Developing an Ordinance and Schedules of Sewerage Charges

By ROBERT A. ALLTON

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This article is printed as the forerunner of a companion article by Mr. Allton, on the same topic, to appear in our next issue. The second article presents the complete Sewer Rental Ordinance of Columbus, recently set up, and discusses important considerations and procedure and policy requisite in the successful production and acceptance of such an ordinance.

The present paper was presented by the author before the American Water Works Association at its 1938 *convention, as the opening paper of a Round Table on "The Sewer Rental Method of Sewerage Financing, and Water Department Collection Experiences." It is reproduced by permission of the Association, as a forerunner to Mr. Allton's more detailed article postponed in order that the present introductory article might appear first.—Ed.*

The Author

THE financing of sewerage works by sewer rentals is of increasing interest to water works managers because of the tendency, in larger cities at least, to base the sewer rental charge on water consumption and thus place upon the Water Department the duty of billing and collecting the charges for sewerage as well as its own charges for water. It is this reason, I suspect, which caused your program committee to ask me to discuss experiences with the sewer rental method of financing sewerage works at a water works meeting. This discussion will attempt, therefore, to give you a general picture of the sewer rental problem and to point out certain ways in which the computation of sewer rental rates and the billing of sewer rental charges varies or differs from the corresponding procedures in a water works.

The advent of the PWA and WPA programs of the federal govrenment, coupled with pressure from State Departments of Health, have in the past few years given impetus to the construction of a large number of badly needed sewage treatment works. While funds for construction were made available in part through these agencies and in part by bond issues, there remained, after construction was completed, the problem of financing their operation. The financial status of many cities has precluded appropriations for plant operation from the general fund and has made it necessary to seek other sources of revenue. As a result, over thirty states have now passed enabling legislation to permit municipalities to make a direct charge for sewerage service and thus make the operation of sewerage facilities self-supporting.

This brings us to one difference between water works financing and sewerage works financing. In the case of water charges, the rates are usually set to bring in sufficient revenue to pay not only the costs of operation and maintenance but also to pay the fixed charges. Whereas, with the great majority of sewerage works, the rates are set to bring in only sufficient revenue to pay the costs of operation and maintenance; funds for fixed charges being raised by taxation. In many cases, however, the enabling legislation provides that any surplus in the sewer rental fund at the end of the fiscal year may be applied to debt service.

Another difference in water works and sewerage works financing is due to the character of service rendered. A water works furnishes a practically uniform product to consumers and consequently the cost of service for any consumer is a function of the quanity of water consumed. A sewerage works, on the other hand, receives from properties served a product which varies not only in quantity but also in strength. Since the strength of the sewage, or industrial waste, directly affects the cost of sewage treatment, the cost of sewerage service for any producer is, in the final analysis, a function of both the volume of sewage discharged and its strength. This point will be considered further in the discussion of rate schedules.

Methods of Charging for Sewerage Service

If the assumption is allowed that the sewer rental charge should be proportional to the use made of the sewerage facilities, the ideal method of computing the charge would be to measure continuously both the volume and strength of the sewage entering the sewer from each premise and, with this data, develop a series of rate schedules based both on volume and strength. This, however, cannot be done because there is no meter available which will accurately measure small volumes of sewage in the condition it leaves the average premise. Likewise there is no means by which the strength of this sewage can be continuously measured and averaged.

It will be readily seen that there is another difference between water works and sewerage works practice in the matter of computing the individual bills. The quantity of water used by any consumer can be accurately metered and the amount of the consumer's bill is this quantity multiplied by the appropriate rate. The quantity of sewage leaving a premises cannot be accurately measured and, in computing the amount of the produ-

cer's bill, recourse must be had to some indirect measurement which bears a fixed ratio to the quantity of sewerage produced, or some other method must be used. This brings us to a discussion of the principal methods which have been adopted in charging for sewer service.

The Flat Rate

One basis of charge for sewer rental is analogous to the flat rate schedule employed by some water works and is illustrated in Table I. Under this plan, the charge for dwellings and apartments is based on the type of building served by the sewer connection, the charge for hotels is based on the number and type of rooms, the charge for stores, restaurants, offices and mercantile establishments is based on the number and type of fixtures and the charge for rooming houses, factories and shops is based on the number of persons living or employed on the premises. This method is open to the objection that the charge for any premise may bear little or no relation to the quantity or strength of the sewage there produced. For that reason the cost of operation and maintenance of the sewage treatment works and pumping stations may be inequitably apportioned among the users. For smaller cities which are entirely residential it may however yield satisfactory results.

In municipalities served by a privately owned water utility the Flat Rate Schedule may prove the most practicable scheme, and in the majority of such cases has been employed in lieu of the more equitable plan of charging on the basis of metered water consumption.

The Fixture Rate

Another basis of charge for sewer rental is illustrated in Table II. Here the charge is based on the number and type of fixtures on each premise and also upon the character of the premise. This method is open to the same objections as the first method described. In addition, the starting of such a plan entails an enormous amount of work, since every building connected to the sewer system must be inspected for the number and type of fixtures.

The Water Consumption Basis

By far the commonest method of determining the charge for sewer rental (as revealed by survey) is to base it on the quantity of metered water, on the assumption that the quantity of water used on a premise is proportional to the quantity of sewage produced. This is, in general, true but there are several conditions, principally in industrial establishments, which may invalidate this assumption and, consequently, this matter must be given careful consideration in establishing sewer service rate schedules and sewer rental ordinances.

Table I—Flat Rate Schedule

Dwellings and Apartments—	
One-Family (one connection)	$4.00 per annum
Two-Family (one connection)	7.50 per annum
Two-Family (two connections)	8.00 per annum
Four-Family (two connections)	15.00 per annum
For each additional family on same connection	3.75 per annum
Hotels—	
For each room with bath	$1.75 per annum
For each room without bath	1.00 per annum
Rooming Houses and Fraternities—	
$4.00 per annum plus $1.00 per annum for each person renting a room therein.	
Stores, Restaurants, Offices, etc.—	
Private Toilets, each	$4.00 per annum
Public Toilets, each	8.00 per annum
Kitchen Sinks, each	4.00 per annum
Slop Sinks, each	2.00 per annum
Factories and Shops—	
For each and every person employed or engaged in services on the premises:	
10 persons or less, each	$1.00 per annum
More than 10 and not over 25 persons, each	0.90 per annum
More than 25 and not over 50 persons, each	0.80 per annum
More than 50 and not over 100 persons, each	0.70 per annum
All over 100 persons, each	0.60 per annum

Table II—Schedule of Charges Based on Fixtures

Appurtenances	*Per Annum Charge*
Dwellings—	
Water Closets, each	$2.00
Bath Tubs or Shower Baths, each	0.50
Sinks, each	0.50
Wash bowl, each	0.25
Rooming Houses and Hotels—15 Rooms and under	
Water Closets, each	$6.00
Urinals, each	1.50
Sinks, each	2.00
Bathtubs or Shower Baths, each	1.00
Wash bowl, each	0.75
Rooming Houses and Hotels—over 15 rooms	
Water Closets, each	$8.00
Urinals, each	2.00
Sinks, each	2.00
Bathtubs or Showers, each	1.00
Wash bowl, each	1.00
Stores, Restaurants, Offices, Barber Shops, etc.—	
Water Closets, each	$5.00
Urinals, each	1.50
Sinks, each	2.00
Bathtubs and Shower Baths, each	1.00
Barber Shops (3 chairs)	5.00
For each additional chair	0.50

One of these is metered water which does not and cannot enter the sewer system. For example: an industry with a large steam power plant may run the engines non-condensing and thus discharge large quantities of water into the air as steam; or a large part of the water used in an industry may be incorporated in the finished product which it manufactures. In such cases, and many similar ones not mentioned, to base the sewer rental charge on the total water consumption would be obviously inequitable. Consequently, provision must be made for exempting such water from payment. This is most easily done by having the premises inspected under the direction of the officer charged with the administration of the sewer rental fund and the percentage of metered water entering the sewers determined with as much precision as possible. The percentage so determinted, and checked at intervals, shall then be applied to each subsequent meter reading to determine the quantity of water upon which the sewer rental charge is based.

Care in Rental Ordinance Drafting

In drafting the sewer rental ordinance the language should be exact and very explicit in describing this procedure, in order that all will be treated alike. The ordinance should also provide that if the customer becomes dissatisfied with the percentage so determined he may, at his own expense, install additional deducting meters and arrange his piping so that such meters will disclose the quantity of water which does enter the sewers. Consideration must also be given to charitable institutions, and similar services, which obtain their water from the municipality without charge. This is a matter of policy, but this policy should be clearly stated in the sewer rental ordinance. Although figures are not yet complete, it is estimated that approximately 25 per cent of the metered water in Columbus will be exempt from the sewer rental charge.

The question of private water supplies must also be dealt with. Here, the simplest solution is to require the installation, on all private water supplies, of approved meters which are read by the meter readers along with

Table III—Schedule of Charges Based on Water Consumption*

Metered Quantity	*Charge per 1,000 Cu. Ft.*
First 25,000 cu. ft. per month	$0.415
Next 175,000 cu. ft. per month	0.40
Next 800,000 cu. ft. per month	0.38
Next 1,000,000 cu. ft. per month	0.345
All above 2,000,000 cu. ft. per month	0.205
Minimum annual charge	1.66

the meters on the municipal supply. The sewer rental charge is then based on the total quantity of water, both private and municipal, with deductions for water which cannot enter the sewers as described above. With the advent of air conditioning and the consequent use of ground water for cooling, this is a very effective method of keeping large quantities of unpolluted water from entering and overloading the sewers, since it is usually far cheaper to drill a drainage well and return the water to the ground or build a private sewer to a nearby water course than it is to pay sewer rental charges.

Charges to Non-Taxed Properties

In many cases a municipality extends sewerage service to adjacent cities, villages and county territory. If the sewer rental charge is to provide revenue for operation and maintenance only, it would be inequitable to use the same rates for the sewered areas outside of the limits of the municipality, since they contribute nothing through taxation toward the fixed charges on the sewerage works. Consequently, the rates for sewered areas beyond the city limits should be increased so that they contribute their share toward the payment of fixed charges. This is readily done by increasing the rates for these areas by an appropriate percentage.

Rate Computations on Quantity-Quality Basis

In computing the rates for a sewer rental charge, based on water consumption, it will simplify computations if the same breaks in quantity are used for both water and sewer rental. Where practicable, the sewer rental rate should be some constant percentage of the water rate. Table III illustrates such a rate.

Mention has already been made of the fact that the strength of the sewage as well as the quantity should be considered in establishing sewer rental rates. To illustrate this mention may be made of one city of 50,000 population where the oxygen demand of the wastes from one industry was equal to the oxygen demand of domestic (household) sewage from 300,000 people. It can be seen that the cost of construction and operation of a sewage treatment works to treat the sewage from this city, with these industrial wastes included, would place a very heavy burden on the municipality unless steps were taken to require the industry to bear its proportional share of the costs. This is an extreme case but serves to illustrate a highly important consideration. In a few cities this condition is met by setting up a series of rate schedules, the charge per unit of quantity varying with the oxygen demand of the waste discharged—the latter being determined periodically by proportional sampling and laboratory tests. In many cases, however, this condition is so infrequent that it can be covered by special agreements with the few industries involved, or the industry may change its method of operation in such a manner as to decrease the strength of its wastes to that of normal domestic sewage. An example of a rate which takes into account the strength of the sewage is given in Table IV.

Table IV—Schedule of Charges Based on Quantity and Strength of Sewage

Water to Sewer Per Month	Charge Per 1,000 Cu. Ft. for Sewage of — Oxygen Demand Indicated —				
		200 p.p.m.	300 p.p.m.	400 p.p.m.	
	Under 200 p.p.m.	to 300 p.p.m.	to 400 p.p.m.	to 500 p.p.m.	Over 500 p.p.m.
First 3,300 cu. ft....	0.245	0.330	0.410	0.495	0.580
Next 30,000 cu. ft...	0.225	0.300	0.375	0.450	0.525
Next 300,000 cu. ft..	0.180	0.240	0.300	0.360	0.420
Over 333,300 cu. ft..	0.135	0.180	0.225	0.270	0.315

*This schedule, adopted for Columbus, is analyzed and more thoroughly discussed in an article to appear in the next issue of WATER WORKS AND SEWERAGE. The article to appear presents the Columbus Sewer Rental Ordinance in detail, discusses considerations to be met and explains the procedure in developing the ordinance.—ED.

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The Texas Manual for Water Works Operators

"Manual for Water Works Operators"—Produced by The Texas Water Works Short School distributed by Texas State Department of Health, Austin, Texas; price $2.00.

Here is a praise worthy manual on water works practices, of recent issue. It was prepared as an activity of the Texas Water Works Short School, under management of its Manual Committee headed by L. A. Quigley, Superintendent of Water, at Fort Worth, Texas, and composed of such authorities as V. M. Ehlers, L. C. Billings, W. S. Mahlie, A. M. Brenneke. It has been ably and painstakingly edited by E. W. Steel of Texas A. & M. College, and is now being distributed through facilities of the Texas State Department of Health.

In its 278 pages appear 19 chapters devoted to specific topics and each prepared by an authority, all of which are Texans and most ably equipped to produce material of special value to Texas engineers and operators, and those in other sections where conditions are similar. These chapters deal with such topics as—"Water and Its Impurities" (Steel); "Surface Supplies" (Hawley); "Sanitation of Watersheds" (Roberts); "Ground Water Supplies" (Harvill); "Pumps and Pumping" (Quigley); "Flow Measurement" (Steel); "Storage Reservoirs" (Winder); "Distribution Systems" (Davis); "Water Treatment Methods" (Billings); "Purification Plants" (Mahlie); "Sterilization" (Puckhaber); "Algae and Its Control in Texas" (Cohen); "Softening" (Green); "Corrosion" (Clark); "Industrial Waters" (Robinson); "Testing—Physical and Chemical" (Bernhagen); "Bacteriological Examination" (Lewis); "Requirements of State Depts. of Health" (Hinyard); "Licensing of Operators" (Gooch).

Five valuable appendices set forth "Sources of Standard Specifications for Water Works Chemicals"; "A List of Suggested Materials and Apparatus for Equipping a Water Laboratory, and Standard Solutions"; "Useful Information" (conversion factors and equivalents); "A List of Useful Publications."

We will not attempt to go into a detailed review of the Texas Manual which is, as we understand it, subject to the customary 10 day inspection by prospective purchasers. We will only say that it is well worth the price asked and the examination allowed.

PENNA. SEWAGE WORKS ASS'N HOLDS LARGEST MEETING

Hears Deputy Att'y. General on New Stream Pollution Law; Enjoys Outstanding Program

"Old Main," State College, Pa.

IT SEEMS to be the fashion of the times for attendance records to be made at association meetings, only to be bettered the succeeding year. Particularly has this been true in the case of the Pennsylvania Sewage Works Association and its sister organization, the Pennsylvania Water Works Operators' Association, which have become far reputed for the excellence of their annual meetings, held conjointly each year on the campus of State College in the heart of Pennsylvania.

This year the Water Operators' Association met on June 7th and 8th; the Sewage Works Association on June 8th, 9th and 10th, with a record registered attendance of 195. On the forenoon of the 8th a joint session was followed by the annual joint Golf Tournament staged in the afternoon.

Meyers Heard at Largest Dinner

The Annual Dinner of the Sewage Works Association, attended by 184 members and guests, was a fitting turnout to hear Pennsylvania's live-wire Deputy Attorney General, Francis J. Meyers, review in an outstanding manner Pennsylvania's progress in stream pollution abatement and present a clear cut analysis of "Pennsylvania's Newest (1937) Stream Pollution Law," and what municipal and industrial polluters were to expect in the way of its enforcement through the Attorney General's office.

Toastmaster H. E. Moses, recently made Chief Engineer of the State Department of Health, in introducing the guest speaker, announced that the people of Pennsylvania evidently liked him as Deputy Attorney General, and his activities in getting through recent anti-pollution legislation, because he had just recently been elected to a seat in Congress. Mr. Meyers stated that the new anti-pollution law was a real one, with plenty of teeth, and had become a reality largely through the efforts of Grover C. Ladner, as Attorney General. It represented the culmination of 15 years of genuine effort by a group of sincere men under Ladner leadership, which was not the kind to be turned back. For not providing adequate treatment of sewage in Pennsylvania the outworn excuse of poverty would no longer be acceptable. To this end Pennsylvania's legislature had legalized financing of sewerage and sewage treatment through issuance of Revenue Bonds, backed by charging sewer rentals, which had already been ordered as the means of financing in certain cases. If municipal authorities fail to act the State, according to Mr. Meyers, proposes to go direct to the people. He asked that every member of the association work shoulder to shoulder with the Attorney General's office and the State health authorities charged with enforcement of the new law. Further, members could do much, he said, in becoming salesmen to the public of the idea that sewerage service is a justified utility service of high importance.

Retiring President Francis S. Friel

Incoming President C. F. Grace.

The Honorable "S.S.S.'s"

At the close of the dinner the Toastmaster inducted four new members into the "S.S.S."—the honor society of the association, which has as its symbol a high-hat of a shade known as "S.S.S. brindle." Into Pennsylvania's "Sludge Shoveller's Society" (try saying it fast while sober; there's no use even trying any other way), were taken the retiring president, Frank S. Friel; the Honorable Francis J. Meyers; and two ex-chief engineers of the Penna. Dept. of Health, Chas. A. Emerson, Jr., and W. L. Stevenson,

Golf Winners

I. M. Glace, Secretary of the Water Operators' Association announced the following winners of the Joint Golf Tournament played on the State College course adjoining the campus, and presented prizes.

1st Low Gross—Ralph Tyler, Scottsdale, Pa. (a repeater).

2nd Low Gross—Reeves J. Newsom, New York City (President of the A.W.W.A.).

3rd Low Gross—E. C. Trax, McKees Rocks, Pa. (better every year).

1st Low Net—M. W. Tatlock, Dayton, Ohio.

2nd Low Net—L. S. Butler, Lemoyne, Pa.

3rd Low Net—John J. Shank, Waynesboro, Pa.

Others to win golf prizes were I. M. Glace, M. G. Mansfield and R. T. Sheen. Door Prizes (by drawing) went to H. E. Lundenberg, Dr. H. A. Trebler, S. W. Long, Chas. A. Hibschman and H. T. Reuning.

(Two of the prizes were 2 year subscriptions to "Water Works and Sewerage" and two were 1 year subscriptions, a compliment to this magazine which is highly appreciated.—Ed.)

Business Meeting

Secretary Matter's report revealed that 34 new members came in during the year. Counting the 15 members

L. D. Matter, Secretary-Treas.

Francis J. Meyers (M.C.), Deputy Att'y General.

added during the meeting, membership in the association now numbers 247. A cash balance of $110 in the bank after paying all outstanding debits, indicates that the association has held its dues to the minimum, and charges no registration fee to members.

On the lamented passing of Isaac Walker, Consulting Engineer of Philadelphia, a fitting memorial was read.

H. E. Moses presented a report on the status of the Federation of Sewage Works Associations, which now comprises 25 affiliate associations with a membership of 2030 as compared with 411 members when the Federation was established 10 years ago. With much satisfaction, he could report that the Journal was now for the first time, being produced without a penny of deficit —that of the past 9 years having been graciously been underwritten by The Chemical Foundation.

A. F. Stone, Supervisor, Reading Treatment Works, as president of the recently formed Eastern Pa. Sewage Operators' Ass'n, reported on the successful meetings (held every second month) of this new organization which serves 15 plants in a 60 mile radius—those of Reading, Lancaster and York being the more important.

New Officers

After progress reports were heard from the committees on Licensing and Correspondence Courses, the Nominating Committee brought in the following nominations which were voted in unanimously:

President—C. F. Grace, State School, Polk, Pa.

Vice-Pres.—G. M. Olewiler, Supt. Drainage, Ardmore, Pa.

2nd Vice-Pres.—G. P. Seabright, Boro Manager, Carlisle, Pa.

Sec'y-Treas.—L. D. Matter, Pa. Dept. Health, Wilkes Barre, Pa.

H. E. Moses and Chas. A. Emerson, Jr., were renamed as members of the Federation Board of Control.

Technical Sessions

In the technical sessions the high-spots were the discussion of "Legal Aspects of Financing Sewerage Projects in Pennsylvania"; "Mechanical Aeration vs. Diffused Air for the Activated Sludge Process"; "The Present Status and What's New in Milk Waste Treatment"; and, "The Sewerage Clinic." The "Clinic" was conducted by "Doctor" H. M. Freeburn, who propounded questions answered from script prepared in advance by those selected for the interviews, after which the "experts" were exposed to free questioning from the floor, and that was where "the spot" got tougher. So successful was "Doc" Freeburn's second "Clinic," that a desire for its continuation the third year was indicated by unanimous vote.

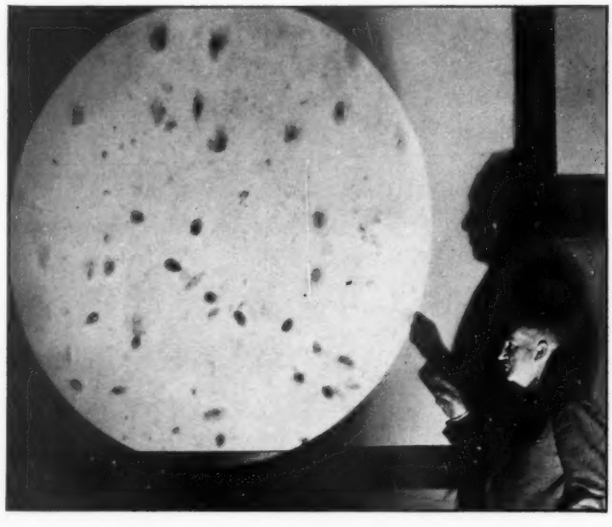
On the evening of June 8th, before a joint session of the Water Works Operators' Association and Sewage Works Association, "Adventures in Electricity" proved to be an entertaining and instructive demonstration of electrical phenomena and scientific devices presented by Dr. Philips Thomas, Research Engineer, Westinghouse Mfg. Company, Pittsburgh, Pa.

The "Precipitron," and its ability to completely purify air of dust, smoke, pollen, and the like, was demonstrated by removing cigarette smoke blown at it. This air filter operates on improved electrostatic principles, and is being successfully employed in a variety of applications.

Perhaps, the most important Westinghouse development demonstrated was that pertaining to a new form of insulation for motors and other electrical appurtenances. Transformers, through its use, will not require the customary oil cooling bath. In comparing insulation of the present with the new, conventional type insulation on a coil was quickly destroyed at 300 degrees C., whereas the new insulation was not affected. It is Dr. Thomas' belief that insulation of the type demonstrated will eventually replace that in present day use.

Dr. Thomas then demonstrated the use of lenses for automobile headlights which polarize the beams and thus eliminate the annoying headlight glare and hazard of night driving. Then, after discussing the fundamentals of the "light beam relay" now widely used, he demonstrated a "breath-relay" scheme. Amusing was his apparent ability, with the use of such relays, to blow out the electric lights on the stage and then light them again with a match.

Then was demonstrated the new "Sterilamp," the rays of which destroy bacteria and larger living forms. On the screen was projected single celled paramecia, much alive until the rays from the "Sterilamp" produced paralysis and death after a few seconds of exposure. Especially, predicted Dr. Thomas, would the new light sterilizer become of value in ensuring sterile conditions in hospital operating rooms, in sterilization cabinets for utensils used in soda fountains and restaurants, and otherwise of importance in the public health field.



Dr. Thomas Demonstrates the "Sterilamp"

To the death dealing invisible rays of the new Westinghouse "Sterilamp" were these Paramecia exposed. The audience actually sees the organisms slow down, die, explode.

"Some Legal Aspects of Financing Sewerage Projects in Pennsylvania," by GEO. F. BAER APPEL, of Townsend, Elliott and Munson, Attorneys at Law, Philadelphia.

Mr. Appel, an expert in municipal utility financing, pointed out the limitations of financing sewerage im-

(1) R. A. McQuade, Simplex Valve & Meter Co., and J. A. Larson of Altoona; (2) C. T. Roland and Dr. H. A. Trebler, Research Dep't, Sealtest, Inc., Baltimore, Md.; (3) W. J. Murdoch, San. Engr., Alleghany Co., Pittsburgh, and H. R. Wellsford, Pa. Dept. of Health, Greensburg; (4) Lester Watson and Paul McCoy, Sewage Treatment Works, Meadville; (5) Arthur Cary, Supt. Public Works, Fairport, N. Y., and Wm. A. Ryan, Consulting Sanitary Chemist, Rochester, N. Y.

provements in past years in Pennsylvania, wherein the issuance of Assessment Bonds and then failure of municipalities to collect the assessments had created much trouble and many suits. Limits on issuance of Assessment or General Obligation Bonds had been 2 per cent of property valuation, without vote of the tax-payers, or 7 per cent if submitted to vote. The passage of The Municipal Authority Act of 1935 had allowed the establishment of a corporation (sanitary district) within the municipality, with authority to issue Revenue Bonds and collect sewer rentals for financing of the project. In 1937 the act of 1935 was amended so that the property of the Authority could not be taken by debtors. At the same time, four acts were passed to legalize financing through issuance of non-debt Revenue Bonds, with sufficient sewer rental charged to cover all maintenance and operating costs, plus interest charges and amortization at the rate of 10 per cent per year. An important feature of the new law is that the charge for sewer rental becomes a lien against the property, and therefore becomes equivalent to a tax to cover Assessment Bonds. Advantages listed by Mr. Appel for the sewer rental type of financing is that costs are fixed on properties served, also that ample funds for effective operation and maintenance are automatically provided for; and, now, the lien law makes for more certain collections. As to legality of the 1937 measure, such is under test now through suit brought by a Pennsylvania city ordered to provide sewage treatment under the new act.

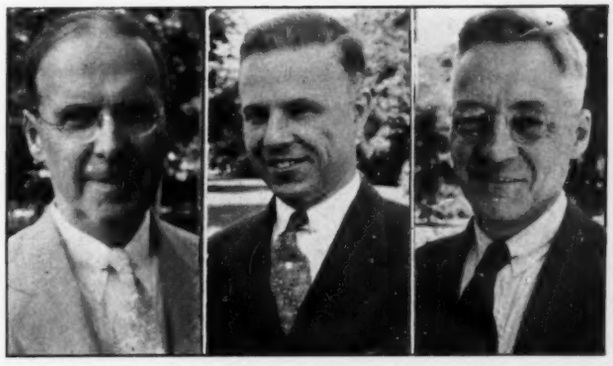
Mr. Appel stressed as an all important factor in setting up financing through Revenue Bonds and sewer rental, that of dependable engineering advice. Confidence in the advisor responsible for evaluating operating costs and depreciation, and in computing rentals sufficient to insure security of interest and principle, was most essential in order to impart confidence in the prospective bond purchasers, insuring a ready market for the securities, and in avoiding future difficulties.

W. L. STEVENSON, Consulting Engineer, Harrisburg, Pa., in reviewing the merits of sewerage financing through the service charge method, pointed out that is was no longer permissive to construct new sewer systems and major extensions in Pennsylvania unless adequate treatment of the sewage was to be provided. Selling sewage treatment on the argument of "better health" had not been easy, because of the difficulty of proving the claims.

W. W. MOREHOUSE, Supt. of Water and Sewage, Dayton, Ohio, requested to state experiences with sewer rentals in Ohio, said that his department had been facetiously named "Dayton's Department of Water—New and Used"; others had added—"and Byproducts and Fertilizer." Dayton appears to have been the first (1928) large community to place sewer rental in operation. The plant had been built from funds from sale of General Obligation Bonds, the rental collections having proved more than ample to cover operating costs, maintenance, and interest on $500,000 of bonds outstanding. The surplus being impounded could not be used for anything other than for sewerage, except that it could not be used for extension of sewers into outlying districts. Fortunately for Dayton the ready availability of the impounded surplus had made it possible to secure secondary treatment (involving 20 trickling filters of 65 ft. diameter) as a Federal aid project at a total cost of but $125,000 to the city. In Ohio, Revenue Bonds were legal but on default in interest bondholders could take over the utility, so financed, and operate it. Concerning experiences in collections, there had been little complaint of sewer service charges, based on metered water consumption, which were added to each water bill. It had been necessary to add but one employee and purchase a billing machine for the extra billing process. From sewer rental collection the Water Department collected 33 per cent of the whole cost of joint billings, as its payment for such service. The few unpaid rentals, like unpaid water bills, were handled by the County Auditor, and constituted a lien on the property. Industrial water consumers had been permitted to measure flow to the sanitary sewers and such readings were used in computing sewer service charges on the same basis as domestic sewage. So far the refinement of making adjustments on the basis of oxygen demand of the waste, had not been undertaken, but had been under consideration as a possible requirement when, and if, necessary. An interesting disclosure made by Mr. Morehouse was that rentals had been collected for a full year before the new treatment works actually began to function.

C. A. EMERSON, JR., Consulting Engineer, New York City, was pleased to hear Mr. Appel emphasize the need for careful ground work and study in arriving at a sound financial pattern. Bankers were automatically shy of the non-secured revenue type of bonds and only a good record of sound financial foundation would place this type of security on a lower interest plane.

The question "What method of charging, and what process of rental collection, seemed best suited for



H. E. Moses, Chief Engr., State Dept. of Health (Toastmaster and Custodian of the "Brindle" Hat); G. M. Olewiler, Supt. Health & Drainage, Ardmore (1st Vice-Pres. and No. 1 Power Saver); J. R. Hoffert, Engr., State Dept. of Health (Long Time Editor of the Ass'n).

"Big-Wigs"

"Mike" Glace, Sec'y-Treas. of the Water Operators Ass'n.; Charlie Emerson, Chairman of the Board, Federation of Sewage Works Ass'ns; "Pat" O'Donnell of State College; "Ted" Moses and "Steve" Stevenson, Past-Presidents of the Association and Members of Pennsylvania's "S.S.S."

Pennsylvania where a majority of the water utilities were privately owned?" was raised. Another—"Was it legal to collect rental before completion of a treatment plant?"

In reply to the last, Mr. Appel stated that the new Pennsylvania act was not clear—most probably illegal though. In answer to the second: there was no specified basis or limitations of rate. The metered water consumption was the preferred basis. Charges based on sanitary fixtures was the next most equitable.

H. N. HERR (Hershey, Pa.) objected to the fixture basis of charging. In Hershey, where both water and sewer utility are privately owned, charges had been made 100 per cent on metered water basis and not a dollar had been lost in sewer rental. Meter readings were furnished by the Water Company.

WM. C. EMIGH, City Engr., Coatesville, Pa., agreed with Mr. Herr. In Coatesville the Dayton scheme is employed, 60 per cent of the water bill being charged as sewer rental. Otherwise, flat rate consumers (small users) are charged the minimum rate. In his opinion the most equitable method of financing was to pay for a good part, if not all, of the actual construction with assessment bonds, especially the sewers, and rely on sewer rent for operation, maintenance and minor betterments.

REEVES J. NEWSOM, President of the American Water Works Assn. (now a practicing consulting engineer and formerly president of Community Water Service Corpn.), stated that he felt that municipal officials would find water company heads entirely agreeable to supply their meter reading records, for use in billing sewer rental on the metered water basis.

Chemical Treatment

"Experiences With Chemical Treatment at Butler, Pa." by T. R. HASELTINE, Superintendent of Sewerage, Butler, Pa.

After a brief description of the Chemical Treatment Plant of Butler, Pa., Mr. Haseltine reviewed operating experiences before and after making necessary improvements, based on studies made since taking charge of the plant. The first requisite was an adequate mixing and flocculating unit. Such, involving air agitation similar to the spiral flow of activated sludge units was installed to provide rapid mix followed by 10 to 20 minutes flocculation at the minimum required rate of air input to provide economical efficiency. Studies with waste pickling liquor and wet copperas from nearby steel mills (chlorinated to oxidize the iron) in comparison with ready prepared ferric salts, indicated the most economical combination to be chlorinated copperas with copperas at $10.00 per ton and chlorine at $2.59 per cwt. delivered. Comparing the new Standard Activated Alum with chlorinated copperas had shown about equal efficacy, pound for pound, but the cost figures favored chlorinated copperas under Butler conditions.

Studies had shown alum to give the best results in a narrow range at or near pH 5.6; iron salts alone at pH 5.7 to 6.0. Because of bulkiness of iron floc in the lower pH zone (3.6 to 5.3) and the greater evenness of floc quality at pH above 8., it had been found overall more economical and dependable to use lime with the chlorinated iron sulphate, to approach pH 9. Between pH 6 and 7 iron salts were least effective and on wash days, with high pH sewage, it proved essential to use lime rather than waste coagulant attempting to drop the pH value into the optimum range 5.7 to 6.

In plant practice the crude copperas was dissolved in a wood stave tank equipped for recirculating. The solution, containing 0.55 lbs. of iron per gallon, was fed from an Omega Precision Solution Feeder. Chlorine, from chlorinators, was admitted to the rubber hose line carrying the copperas solution from the feeder to application point. Hydrated lime, from dry feeders, was applied ahead of the chlorinated copperas at rates averaging 80 p.p.m. but varying from 40 to 100 p.p.m. to meet

Campus Scenes

(1) The "Nittany Lion" Inn Overlooks the Golf Course; (2) Larson McQuade, Swab, Kappe, Barrick Hold a "Pow-Wow" Under the Trees; (3) Domestic Science Hall, Where Meetings Were Held; (4) Somebody Is "Putting the Dog" on McCrory; (5) One of America's Handsomest Dormitory Groups Where the Boys Do a Little Sleeping—Yes, Very Little.

W. W. Morehouse, Supt., Dayton, Ohio (Heads a Dept. of Water—New and Used; Collects for Its Going in—and, Coming Out); E. B. Wagner, Boro Engr., Downingtown, Pa. (Holds Down a Like Job in Downingtown); H. N. Herr, City Engr., Hersey, Pa. ("Not a Dollar Loss in Sewer Rent Collections").

(1) *Smiling John Boardman, Cons. Engr. of Philadelphia;* (2) *A. B. Carson of Albright and Friel Engrs. (Ass't to the President of the Ass'n);* (3) *Grove Starr, Operator, Pennhurst, Pa.;* (4) *John R. Sperry, American Well Works, Aurora, Ill. (Son of Walter A.);* (5) *Handsome Jim Baty, Penna. Salt Mfg. Co.'s Technical Service Engr.;* (6) *F. S. Lubrecht, Cons. Engr., Hazelton, Pa.;* (7) *"Sam" Zack (came from Chicago's Sanitary Dist. to make good with Filtration Equipment Corp. of N. Y. City);* (8) *Bernard H. Swab, Sewerage Engr., Altoona, Pa.*

conditions. Pre-chlorination for odor control was effectively practiced at varying dosages insufficient to produce a residual. For the 1937 season of chemical treatment the following were averages—flow 2.11 M.G.D.; chlorine 12.9 p.p.m.; iron (expressed as Fe) 11.9 p.p.m.; lime 42 p.p.m. at a total chemical cost averaging $8.75 per million. It was noted by Mr. Haseltine that only the flow between 7:00 a. m. and 10:00 p. m. was treated, whereas the cost calculations included the weak night sewage flow—that is, the entire plant output.

As to purification attained, the average 5 day B.O.D. removal was 58.7 per cent; suspended solids 73 per cent; settleable solids 89.7 per cent; turbidity 64.4 per cent. The sludge (2,527 cu. ft./day) had a pH value of 6.5 and contained 4.35 per cent solids, 62.8 per cent of which was volatile. Observations had justified the conclusions that the use of lime is justified; that the residual chlorine in the coagulating stages is not justified, but that partial prechlorination was essential to the success of the treatment. In addition, the effectiveness of residual chlorine in the effluent had been indicated in observed stream conditions.

Further improvements now under way at the Butler plant include an extension to the mixing unit to provide not less than a 15 minute flocculation period; conversion of the clarifiers to center-feed units; new dry feed machine to increase lime feed; two new solution vacuum-feed chlorinators, to replace direct feed. Mr. Haseltine stressed the point that such improvements could be expected to effect higher reductions in oxygen demand, better appearing effluent, and likely savings in chemical costs had also been indicated. The interesting part about a chemical treatment plant, he added, was that, with little sacrifice of apparatus, it could be converted to a plant providing biological secondary treatment if and when necessary.

H. W. GEHM, New Jersey Exptl. Sta., New Brunswick, N. J., a scheduled discussor, stressed the importance of proper plant design, with adequate and dependable equipment capable of high flexibility, in chemical treatment, if efficient performance and economy was to result. Considering these shortcomings the Butler plant had done a fair job under Mr. Haseltine's analytical supervision, although the dosage of iron coagulant seemed to be rather high. At Butler as elsewhere the soapy alkaline sewage of wash days (usually Mondays) was a problem in chemical treatment. He checked with Mr. Haseltine's observation as to the efficacy of partial pre-chlorination (no residual chlorine) in chemical precipitation. In adding acid to reduce the pH, and thereby iron requirements, he had found better results came from adding coagulant first and acid thereafter, rather than adding both together. Chlorinated-copperas had one shortcoming—namely, the control of copperas feed and chlorine feed. To insure best results a fair excess of chlorine, above that required to oxidize the iron, seemed an important factor in avoiding reduction of iron by the sewage and speeding flocculation.

L. H. ENSLOW, Editor of "Water Works and Sewerage" and Engineer of The Chlorine Institute, New York City, appreciating the importance of alkalinity and pH fluctuations in chemical precipitation, called attention to the scheme being employed at the Atlanta, Ga., plant. This development under M. T. Singleton, Atlanta consulting engineer, involved the ingenious scheme of blowing cooled exhaust gases from gas engines through the crude sewage in the flocculating chambers. The most interesting feature was that the more alkaline the sewage the more rapid did it take up the carbon dioxide. Further, that the pH value of the sewage being gassed came down quickly to a pH between 6 and 7 and almost as if automatic the curve of the lowering pH value flattened out at pH 6 or slightly above. This scheme had particular value in maintaining pH value on a much more even base and, thereby, insuring a more even coagulation at a chemical saving. Since the Atlanta sewage at the Entrenchment Plant suffered marked pH fluctuations, due to laundry or industrial waste, the scheme had proved especially worthy. Possibly even higher efficiencies might be had from the use of digester gas which contains a higher content of carbon dioxide and would not involve pre-cooling. Its use, however, would entail risk of fire or explosion and the gassing chamber would have to be constructed as a scrubbing unit, delivering the scrubbed gas to the gas-holder supplying the engines. In the latter scheme the volume of gas to be stored would be reduced by the amount of carbon dioxide removed; the gas would be richer and essentially freed of those sulphur compounds which have caused corrosion troubles in heating boilers and gas engines.

Perhaps the scheme of making chlorinated copperas solution by the batch method might be worthy of comment. At the larger Atlanta plant chlorinated copperas for sludge conditioning was being produced by recirculation of copperas solution and chlorination simultaneously. As the copperas underwent oxidation, the temperature increased, and more copperas could be added to raise the concentration.

S. I. ZACK, Filtration Equipment Corporation, New York City, revealed some of the Chicago Sanitary District findings in respect to chemical precipitation of rather dilute sewage, under study on a small plant scale, involving a strainer on the settling tank effluent. In B.O.D. removals and in polishing the effluent, chemicals used in conjunction with the strainer had raised the reduction in B.O.D. to 75 per cent, at a $4.00 per m.g. cost of chemicals. The polished appearance of the effluent had proved an added value not revealed in laboratory measures of efficacy and giving the impression of purification well above the 75 per cent recorded.

The Sewage Clinic

("Doc" Harry Freeburn—Clinician)

In a well ordered manner, and reading from script prepared in advance, the questions put by "Doc" Freeburn and the answers given by his "patients" sounded very much akin to interviews as broadcast over the air. Both questions and answers were easy to follow.

Case No. 1—**"What Can Be Done to Reduce Plant Power Bills?"**

GRANT M. OLEWILER, Supt. of Health and Drainage for Lower Merion Township, Ardmore, Pa., being interviewed, went into the causes for high demand charges and possible methods of getting a lower charge or a new rate from the power utility. He pointed out that the method of basing rates and billing on the maximum power demand, even though momentary, justified every permissive way of programming pumping and other power taking operations so as to eliminate every possible peak through the total-load (demand) meter. After that, a study devoted to electric bills might easily reveal that the charges could be further trimmed by demanding a switch to some more favorable rate schedule, of which power companies had many. He cited a case in which tailing illegal water and leakage into sewers, to minimize peak flows. Furthermore, judicious use of the storm flow bypass might not be "cricket," in the eyes of stream authorities, but was definitely a means of saving much money with but a few hours of such storm flow by-passing into swollen streams. This, he added, provided the operator could get away with it.

Asked to tell as simply as possible what was meant by the "power factor," Mr. Olewiler explained that it was, in short, the ratio between the amount of work performed by a motor and the quantity of energy placed into it. That is if the K.W. load as measured by the active meter be graphically plotted as a base line and the K.W. load as measured by the reactive meter be plotted as the perpendicular, then the hypotenuse line formed represents the actual energy used. The latter divided into the energy measured by the active meter is the mysterious "Power Factor," which is only a percentage of the "energy line." In billing the power factor of the motor, taken into consideration with the demand charge, affects consumption charges. To correct a poor power factor compensating condensers might be installed to balance the motor, as had been done at some plants. Another method was to specify synchronous motors in

(1) M. W. Tatlock, Supt., Treatment Works, Dayton, Ohio (Took back the No. 1 Golf Prize). (2) "Sam" Newkirk, Supt. Water, Elizabeth, N. J. (Stayed to learn what they do with "Used Water"). (3) Charlie Young, Distr. Engr., State Dept. Health (Didn't think much of the plant on Main St.). (4) Joe Harris, Asst. City Engr., Sharon, Pa. (5) Wm. C. Emigh, City Engr., Coatesville, Pa. (Past President of both Ass'n). (6) H. F. Watson, Development Engr., Link-Belt Co., Phila. (7) J. D. Woodward, Supt. of Sewerage, Conshohocken, Pa. (Has as many motors in his plant as a dog has fleas.) (8) "Larry" Morgan, Distr. Engr., State Dept. Health, Greensburg (with Ye Ed, he's been in the dog-house).

$300 per year had been saved by such a switch. Mr. Olewiler then told of a study which had shown that installation of an additional battery of transformers and separate meter, for metering on primary voltage, had made possible a saving of $2,400 the first year on an investment of $2,000 for outright purchase of the transformers. Power-wasting "leaks" could be corrected by checking up pump efficiencies and the accuracy of flow meters and gages. He stressed the value of selecting motors and pump units for their maximum efficiencies, with less regard for initial cost. In short, the more expensive motor-pump units were generally of an efficiency to quickly pay for itself on the "hidden installment plan." In other words, power costs saved monthly, which if capitalized would show a nice saving.

(Mr. Olewiler could have added that a unit of high initial efficiency (regardless of cost) might be of a design to wear too easily and, thereby, shortly drop to an efficiency lower than another unit designed for lower initial performance but higher in long-period sustained efficiency. Whatever it takes to assure sustained pump efficiencies is worth the money it takes to get it, and constitutes an axiom of worth in pump selections. In sewage pumping, high efficiencies are assuredly the least of the assets to consider in making selections.—Ed.)

And then, in sewage pumping Mr. Olewiler said that the all important power demand charge (now termed "assessed demand charge") justified considerable expenditure in maintaining maximum infiltration, and curdesigning the plant, or in replacements. This type motor, having 100 per cent power factor, tended to balance others with low factors. Another help was to see that the motor had the 25 per cent overload feature, and to remember that an expensive efficient motor was in the end the cheapest motor.

G. H. BOONE, Plant Superintendent, Morristown, Pa., related some of Norristown's experiences with separate metering on the primary side to secure reduced rates on off peak hours. They, however, had preferred to pay rental for the required transformers and let the power company carry all responsibility for their maintenance. He mentioned the steps taken to avoid all or most of the automatic pump units from kicking in just to care for a peak flow of one hour or so daily. To hold down the demand factor they had let the sewage back up in the sewer during peak flows, to substitute for the construction of a larger collecting basis with its maintenance problems. With flat grade sewers possibly this could not be satisfactorily done, but it had worked satisfactorily at Norristown.

ED. B. WAGNER, Borough Engr., Downingtown, Pa., told of their scheme of separate meters and use of off peak power between 9:00 p. m. and 7:00 a. m. to the permissible minimum.

WM. C. EMIGH, City Engr., Coatesville, Pa., stating that the use of off peak power in water pumping was far simpler than in sewage plant operation, said that at Coatesville they were studying the feasibility of buying

W. L. Stevenson, Metcalf & Eddy, Engrs., Harrisburg. C. A. Emerson, Jr., Gascoigne Associates, New York City. B. S. Bush, Assistant to Sec'y Matter, Wilkes-Barre.

power in bulk delivered at one or more central points at a more favorable rate. The city would then distribute it for the several uses and do its own plant metering.

Case No. 2—**"Operating Difficulties at the New Farrel Treatment Plant"**—were brought out by questions put to NOEL S. CHAMBERLAIN, Supt. of Treatment, at Farrel, Pa.—a "Main Street" town, with its sewage plant built at the end of Main St., because there wasn't much place else to put it.

In addition to a detritor mechanism that didn't fit; sewers that spilled into the river instead of the plant; oversized pumps and motors; a floating cover that tilted because a sagging gas line became water bound; replacement of original gas meters with ones of proper metal, having condensate bleed cocks; and Venturi lead line troubles, he had an automatic bar screen that would not "automat" when most needed in the spring thaw, when loads of ashes came down on him.

In the subsequent discussion it developed that engineering supervision on the Farrel plant construction had been lacking. Opinions were that the engineers designing the plant were possibly to be blamed in not insisting that a resident engineer be put in charge.

In an attempt at diagnosing the failure of the automatic screen (operating on head-differential), it was the opinion of L. H. ENSLOW that the entrance to the float tube should not be near the bottom of the channel. Most likely the partly blocked bar-screen checked velocity and allowed grit and ashes to deposit. Therewith the port to the float chamber was closed so effectively as to render the automatic screen mechanism non-automatic, and bad matters led to worse.

Case No. 3—**"Settling Tanks,"** brought Jo. J. GILBERT of Link Belt Co. to the cross-examination bench.

Some of the pointers brought out in the interrogation were that in longitudinal tanks the collector mechanism should be operated prior to sludge transfer only, and then only long enough to completely traverse the length of the tank. That is, at the speed preferred (2 ft./min.), 30 minutes of collector operation was ample for a 60 ft. tank. Secondary tank mechanisms (trickling filters) have usually not been frequently enough operated nor has sludge been frequently enough withdrawn to prevent septic zones. In activated sludge plant, continuous mechanism operation was essential. Mr. Gilbert recommended emptying of tanks for mechanism and bearing inspection at 6 month intervals; weekly greasing of above-water bearings; change of oil in speed reducers fall and spring.

M. B. TATLOCK, Supt. Treatment Works, Dayton, Ohio, went Mr. Gilbert one better by saying that his experience had indicated that mechanisms in secondary tanks, serving trickling filters, should be operated practically as continuously as those handling activated sludge.

Case No. 4—**"Sewage Screens"** had ALAN DARBY of The Dorr Company on the spot.

To the first question, Mr. Darby replied that fine mechanical screens were more used in industrial waste treatment and constantly less indicated for domestic sewage. A short period scum and grease separation and detritus removal tank was far preferable; does a better job at less overall cost and with less nuisance. Where ocean dilution was available, centrifugal dewatering and incineration of screenings cake might bring fine screens back to favor. He then dwelt on the proper design and installation of mechanical bar screens, operated by time-clock at selected intervals. Or, preferably, full automatic rake operation, functioning in step with loss of head through the screen. As to bar-screenings disposal, shredding and return to the sewage was meeting with increasing favor.

Case No. 5—**"Degreasing Sewage"** was the last "case" handled by the "Clinic," but proved of top interest. Here, GORDAN J. WEIST, Chemist, Lancaster Sewage Treatment Works, related the newest (and most overall revealing) experiences with the new "Aero-Chlorination" method of liberating grease from sewages. In the method a small quantity of chlorine gas is admitted to the air lines supplying 3 to 5 minute aerating chambers ahead of the primary settling units, the floated grease (in the form of foam) being removed by skimming.

Mr. Weist briefly recounted the already published results from the Woonsocket, R. I., and the Baltimore, Md., plants. (See W. W. & S. for May, 1937, and Feb., 1938.) And then proceeded to go these one better in revealing results at Lancaster, since August, 1937, where the period of "Aero-chlorination" was limited to between 3 and 4 minutes, and 2 ppm chlorine dosage proved ample in conjunction with 0.1 cu. ft. of air per gallon. Based on parts per million of grease in the Lancaster sewage, chlorinated air had removed 76 to 80 per cent as compared to between 50 and 53 per cent when using air alone. Based, however, on floated grease scum removed in pounds per million (dry basis), aero-chlorination increased removals by 308 to 417 per cent over air alone. Asked for his conclusions respecting aero-chlorination, Mr. Weist stated that use of the method had eliminated bulked sludge and other operating difficulties. The grease content of activated (returned) sludge had been reduced by 64 per cent. Aero-chlorination had, as a result, been adopted as a permanent part of the activated sludge process at Lancaster, in which 0.1 cu. ft. of air per gallon and an average of 2 p.p.m. chlorine applied (based

N. S. Chamberlain, Plant Supt., Farrel, Pa. (His Plant at the End of Main St. Had One Asset—a By-pass). F. W. Jones, Gascoigne Associates, Cleveland, Ohio ("What's Well Begun Is Half Done"). Gordon J. Wiest, Works Chemist, Lancaster, Pa. (Degreased Lancaster Sewage; Put the Plant on an Even Keel).

on sewage flow) has been taken as the satisfactory combination for the 3.9 minute average detention period available.

In reply to questions, Mr. Weist had found little difference in grease extraction results when using petroleum ether, as compared to chloroform. Since using aero-chlorination, less bulking of sludge had been noted and Lancaster had experienced 6 months of continuously good operation for the first time.

F. W. JONES, Gascoigne Associates, Cleveland, Ohio, reported that pre-aeration for 6 minutes and grease skimming from the primary clarifiers was being adopted at Cleveland, with provision for adding chlorine to the air lines.

Treatment of Milk Wastes

"Milk Waste Treatment," by DR. H. A. TREBLER, National Dairy Products Co., New York City.

Dr. Trebler's paper, read by C. T. Roland, an associate, proved a veritable compendium of information pertaining to milk waste treatment, which can not be done justice in a digest of this nature. Its appearance in Sewage Works Journal should be watched for by those interested in the same problem that confronts the industry represented by Dr. Trebler. In his review he pointed out failures and successes, stating that even the ill-reputed septic tank, if of sufficient size, had actually removed grease and reduced B.O.D. of milk wastes by 50 per cent, the effluent being very amenable to further purification on trickling filters. The activated sludge process had proved satisfactory where properly operated, its high cost being the chief drawback.

The Guggenheim process, in use for five years at Glen Karn, Ohio, held promise as a biological process assisted by chemical precipitation. Sudden heavy loadings of whey had upset the process but, on the whole, it had performed very commendably and dependably, handling a cheese plant waste varying between 600 and 2,000 p.p.m. in B.O.D. value, except when whey dumpings occur to raise the 2,000 B.O.D. ten fold. A regulated flow of 1,000 gals. per hr., from a storage tank, after receiving lime, an iron coagulant ("Ferrisul") and return sludge, receives four hours of aeration at the rate of 4.5 cu. ft. of air per gal. in summer and 3.0 cu. ft. in winter. The resultant bio-flocculated sludge separates in a tank providing a 2 hour (constant) detention period. Final effluent returns to the storage tank during night flows, to keep the plant in continuous operation at constant flow. Interesting was the disclosure that

Programmers

Dr. H. A. Trebler, Director Research, Sealtest, Inc., Baltimore, Md. T. R. Haseltine, Supt. Treatment Works, Butler. Pa. Wm. L. Sylvester, Ass't Chief Engr., Dept. Public Works, New York City.

Mechanical Aeration vs. Air Blowing and Referee

Sam E. Kappe, Engr., Chicago Pump Co., Philadelphia, Pa. (the Case for Mechanical Aeration). Chas. C. Agar, Senior Engr., N. Y. Dept. of Health, Albany, N. Y. (The Referee). Frank C. Roe, Engr., Carborundum Co., Niagara Falls, N. Y. (The Case for Air Diffusion).

the sludge is digested in lagoons, and without odor nuisance. Power consumption runs constantly at 3 KW. Labor necessary is only about 1 hour daily, and no particular skill is required to keep the plant going evenly and productive of an effluent consistently under 50 B.O.D. value, said Dr. Trebler. The compactness, freedom from nuisance, and low installation cost of the plant were all attractive features, as compared to orthodox trickling filters. The chemicals involved (20 lbs. of hydrated lime and 30 lbs. of "Ferrisul" per day) result in a chemical cost of $1.00 per day, in treating 24,000 gals. A second Guggenheim plant, installed at Marshall, Indiana, operates on cheese wastes also, but having less efficient aeration has so far not produced effluent of the quality of the Glen Karn plant. This, for reasons not yet determined, unless it be the shallow design of the aerating units and too large perforations in the air distribution pipes to maintain dissolved oxygen and effective bio-flocculation.

Concerning the rapid flow type (Halvorson) trickling filters, the most authoritative results had come from an installation at Wellington, Ohio (other such filters being at Summitville, Ind., and Nunda, N. Y.), where it has been in service now for 3 to 4 years. Reduction in B.O.D. had varied between 19 and 83 per cent—52.2 per cent being the average—giving a removal of B.O.D. amounting to 1 lb. for each 8.7 cu. ft. of filter bed. However, the waste applied had passed through a septic tank of 12 hours detention, turning out an effluent averaging 880 p.p.m. B.O.D. At Summitville the filter receives fresh waste after brief settling, but the plant has been too overloaded to justify much discussion. At Nunda the reverse was true.

Mr. Trebler then revealed some experimental findings on high rate trickling filters filled with tin cans, having first had their bottoms punched in. Indications were that filters 6 ft. deep (each), in series of three units, produced overall the most efficient results at a rate of 5.3 m.g.d./acre (3 times the area of one unit taken in the computation), with removals of 1 lb. of B.O.D. for each 8 cu. ft. of bed volume being attained. Forced draft had not been found of value but recirculation of effluent and higher rates of application seemed to have advantages in improving distribution and in equalizing rates and strength of applied waste. The possibilities of tin-can filters, based on promising results to date, would continue to be explored.

C. L. SIEBERT, Engr. in Charge of Stream Pollution Investigations, Pennsylvania Department of Health, was struck with the possibility that trickling filters in series might handle milk plant wastes at high rates. That each 8 to 10 cu. ft. of bed volume proved capable of removing 1 lb. of B.O.D. per 24 hours, as compared with the con-

C. L. Siebert, Engr., State Dept. Health, Harrisburg. Alan A. Darby, Sales Engr., The Dorr Co., New York City. W. C. Taylor, Director-General), Sharon, Pa.*

ventional filter which required 80 cu. ft. of bed material for every pound of B.O.D. removed, was most impressive. He believed that the Halvorson or some other high rate trickling filter had genuine merit and the biochemical Guggenheim process considerable promise. Although there was much discussion relative to the patent situation in each, polluters must do something promptly, because of complaints, and pay the royalty or take a chance on being sued; or else treat by one of the older schemes.

PROFESSOR E. D. WALKER, State College, Pa., told of troublesome fungus growths in sewers and the treatment plant at State College, which had been eliminated by adding lime to maintain an alkaline reaction of 50 p.p.m. phenolpthalein alkalinity.

In closing the discussion, Dr. Trebler again mentioned the value of the septic tank, if not overloaded. As to the high rate filters, he agreed with Halvorson that effective distribution was an important factor. Concerning patents and royalties, the industry did not worry, believing that the inventor should have fair compensation. In dealing with the Guggenheim interests the payment of a lump sum, as the only charge, had been satisfactory.

Mechanical Aeration vs. Diffused Air

In two enlightening papers the merits and costs of mechanical aeration as compared to air diffusion were set forth by two qualified speakers. The most interesting part was the fact that the claims of the two debaters were in such close agreement as to leave little room for argumentation except on relatively minor factors and assumptions.

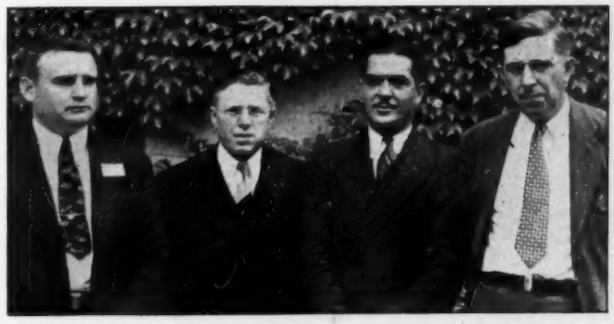
"The Case for Mechanical Aeration," by S. E. KAPPE, Engineer, Chicago Pump Company, Chicago.

In presenting the especial advantages of mechanical surface aeration for the smaller plants, Mr. Kappe stated that relatively small aeration units of 50,000 gals. maximum capacity had been found most flexible, economical of power required and overall most effective. It had been found that such units should be operated to secure at least three tank turnovers per hour and connected in series for best results. In properly designed mechanical aerators, 70 to 80 per cent of the total purification was accomplished in the first hour. In most efficient operation the effective control of returned sludge was a highly important factor. The optimum quantity of sludge to be carried in the mixed liquor hinged on another important factor—namely, "sludge activity." Usually not more than 1,000 parts per million of sludge could be carried successfully and at times the maximum permissive might be as low as 300 parts. With mechanical aeration "oxygenation capacity" was more limited than with diffused air, thus necessitating somewhat longer aeration periods, depending upon many factors—not the least being sludge activity and "treatibility" of the sewage. In mechanical aeration an important feature was the ability to vary the speed of turnover of tank contents in order to cope with changing conditions of sludge and sewage, seasonally or as the result of erratic plant loadings.

Concerning power requirements, Mr. Kappe stated that the minimum power consumption, safe to predict in mechanical aeration, was 0.35 K.W.H. per pound of 5 day B.O.D. removed, amounting to roughly 18 H.P. per million gallons of average domestic sewage with a B.O.D. of 200 parts. However, for stronger sewages the power consumed, per pound of B.O.D. removed, had proved lower and for weaker sewages, higher. In comparison with air diffusion, the power consumed for a given removal of equal weight of B.O.D. by mechanical aeration had been shown to be about the same in each case, with a longer period of aeration at lower power input rate in the mechanical process. One distinctive feature of mechanical aeration, however, was the flexibility in power input made possible by "off-and-on" operation of the mechanism, automatically controlled by a time switch. Where permissive, complete units might be held out of service without overloading the remainder. Presenting and analyzing data for 11 mechanical and 8 air blowing plants, Mr. Kappe showed that power consumption per M.G. averaged 842 K.W.H. for mechanical plants as compared to 766 K.W.H. for air blowing plants of generally much larger capacities. Power costs ran from $19.30 to $24.40 per M.G. for the mechanical plants.

Concerning "Construction Costs," Mr. Kappe gave figures from 15 mechanical plants up to a capacity of 2.25 M.G.D., revealing costs from $80,000 to $310,000 per M.G.D. capacity, the average being $148,000. On a per capita basis the average was $19.30, with the lowest being $8.00. Comparing costs of 15 mechanical and 9 air blowing plants, by graphical presentation it was shown that mechanical plants became less costly for design flows of 1.5 M.G.D. or under. In existence in the United States are 88 mechanical plants, the largest being the 4 M.G.D. plant at Elmhurst, Ill., the smallest being one of 70,000 G.P.D. at State Park, S. C.

Mr. Kappe's conclusions were that first cost entered into the choice of mechanical or air blowing plants as the primary difference. Since so much hinged on efficiency of plant management, power consumption comparisons, without knowing the circumstances, could not



"Brass-Hats," Eastern Pa. Sewage W'ks Ass'n

A. F. Stone (Reading), President; E. B. Swineheart (Pottstown), Treasurer; C. N. Lauer (York), Vice-President; J. H. Shertzer, City Engr. of Lancaster, Who Served as the First President. Missing From the Picture Is the Secretary, G. J. Wiest (Lancaster).

(*Public Safety, Sewerage, Garbage, Lighting, Plumbing, Milk, Health; and, now, Parking Meters, are the few odd jobs he has in Sharon.)

be taken as the criterion in comparing one method of aeration against the other. There were more important factors to consider, such as the adaptability of equipment and its flexibility, designed to permit maximum efficiency in power usage.

"The Case for Air Diffusion," by FRANK C. ROE, Engineer-Manager of Sanitary Sales, The Carborundum Company, Niagara Falls, N. Y.

Mr. Roe stated that at present there are almost 200 diffused air plants, about 20 combined mechanical and air diffusion plants, and close to 100 mechanical aeration plants in operation in the United States. Figures employed in his analysis and evaluations had been secured from 16 mechanical and 25 air diffusion plants, and were presented in tabular form. Mr. Roe used, as the most universally representative yard stick for comparison, the "work done" unit of K.W.H. per pound of B.O.D. removal in the aeration stage. Presenting these figures in graphic form revealed that power consumption for such "work units" was found to be somewhat higher in the air diffusion process at plants of less than 7 M.G.D. design capacity, although the data on mechanical plants were less complete or representative of year-round operation. In fact, for the most part, the mechanical plant data available were that supplied by manufacturers of mechanical aerators and from short period tests only. Data collected also indicated higher power consumption for diffused air alone than for combination of mechanical and diffused air in plants treating flows of less than 2.5 M.G.D.

Comparing construction costs, a second graph revealed that the first cost of mechanical plants was lower (in terms of dollars per M.G.D. capacity) for plants of less than 0.65 M.G.D. capacity, the gap becoming the wider as the plant size decreased.

Combining "Power Consumption" and "Construction Costs," into a third graph, produced the "key" to indicate the optimum range of plant capacity, below which mechanical aeration seemed the more favorable and above which air diffusion was more favorable. The difference in cost of plants appeared the most important of all of the factors involved. Therefore, such difference was converted to "interest saved" figures, and as such are legitimately subject to deduction from power cost in arriving at overall cost figures, which, in the end, must be the real criterion in making comparisons. In the adjusted graph mechanical aeration was found in the more favorable position for plants treating less than 1 M.G.D. flows; air diffusion plants for all flows above 1 M.G.D.

Mr. Roe brought out another worthy point of consideration in comparing overall costs—namely, the matter of power generation by gas engines in which the most efficient usage of such power is in air compression. Another was the ability to graduate the air input in diffused air plants to give maximum aeration at the inlet of the aeration unit, where most needed, and thereafter taper off the air toward the outlet end for maximum economy.

(By two separate routes, it is interesting to find that independently Mr. Kappe and Mr. Roe agree so closely as to be within a half million gallons as the upper limit of plant capacity wherein mechanical aeration deserves consideration over air diffusion. If Mr. Kappe accepts Mr. Roe's reasoning, in crediting interest saved on capital investment as an overall annual cost reduction, then the gap between Mr. Kappe's 1.5 M.G.D. capacity and Mr. Roe's 1.0 M.G.D. capacity, as the dividing line, will be for all intent completely closed.—ED.)

CHAS. C. AGAR, Senior Sanitary Engineer, New York Department of Health, in discussion said that he liked Mr. Kappe's expressive and meaningful expression, "Treatability" of the sewage. It was interesting to note the close agreements in the conclusions reached independently by both speakers. Nothing had been said concerning the temperamental nature of the activated sludge process, which should not be overlooked. It was his belief that for the smaller installations, and especially with high rate developments, the trickling filter still had a future.

"Starting a New Sewage Plant," by FRANK WOODBURY JONES, Gascoigne & Associates, Consulting Engineers, Cleveland, Ohio.

Using as his theme,"What's well begun is half done," Mr. Jones presented an excellently thought out and splendidly delivered paper, containing much logic born of experience, and a number of valuable pointers pertaining to starting and tuning up new treatment plants. Sewer rental had proved the most equitable and overall satisfactory means of securing adequate and regular operating funds. Present day economics of sewage treatment demanded the fullest permissible recovery of by-products—the most important being power developments with sludge gas engines. A power taking analysis to hold down the power demand factor by operating no greater number of motors at one time than is essential offered much in potential savings, and many times a handsome return for the effort. While the sale of dried sludge as land improver made a good showing, the psychological effect of cash receipts was of more value than (in truth) any appreciable profit. In the long pull, selling the authorities on financing good maintenance, and making prompt repairs to equipment and structures, would show in dollars *unspent*, and in replacements never purchased, a laudable margin of profit.

Concerning oxygen demand, Mr. Jones explained that this term applied to plant performance from bar-screens to effluent weir. In starting a plant it was advisable to take into service one device or unit at a time, until the whole ran smoothly. Amongst suggestions offered, Mr. Jones said that new or emptied sludge digesters should not receive full load until digestion is thoroughly established and thereafter the load be built up. During this period the gas line should be disconnected to prevent foam or scum from reaching the meter or other gas handling equipment—a simple precaution which has avoided much grief. In gradually building up digestion, lime has never been needed to check acidity or to provide the 1,500 p.p.m. total alkalinity needed in the liquid to avoid foaming difficulties. The optimum digester temperature seemed to be at or near 90 deg. F. In the beginning the gas is too high in carbon dioxide to burn. However, when 40 per cent by volume is found, it is burnable and such may be revealed by collecting a Nessler tube full of gas, adding a little caustic soda solution or lime emulsion, shaking and opening under water (with open end down) and reading. The loss in gas volume noted (water height in the tube) represents the carbon dioxide originally present, and absorbed in the test. In closing, Mr. Jones made a plea that unseasoned operators be not too hasty in condemnation of designers or equipment contractors until either or both had been given a fair opportunity to inspect and correct minor shortcomings.

WM. L. SYLVESTER, Ass't Chief Engr., Sanitary Div., Dept. of Public Works, New York City, agreed that operators should be slow to condemn and diligent to correct deficiencies. He cited some of the difficulties experienced in getting New York's Ward's Island plant going on an even keel. He thought that continued contact with consultants was justified on grounds of the benefit of their broad and impartial knowledge.

GLANCES AT RECENT WATER TREATMENT PRACTICE

By L. L. HEDGEPETH*
Pennsylvania Salt Mfg. Co.
Philadelphia, Pa.

"Hedge"

THE substance of my contribution to this discussion is that exact science in sanitation is proving not so exact—not so fixed. Chemists are agreeing to disagree, even to disagree on how to disagree. In fact, we may hazard the observation that the most consistent thing about chemists is that they do disagree.

It is all very confusing to the would-be orderly mind. And, it is apparent that "2 + 2 = 4" is not necessarily always the case. For two elephants and two bags of peanuts do not make four elephants—neither do they make four of anything else. Likewise, we may consider the sad plight of some of the more dissolute and trusting members of this audience, who are today poorer and wiser after considering two deuces showing last evening as simply two deuces, when in reality they were not two deuces at all, but a very necessary and soul comforting complement of three aces.

Some Purification Paradoxes

Let's consider some recent water purification paradoxes:

Lime treatment of finished water does not stop tuberculation—it may stop red water. Main cleaning removes tubercles, but also makes them grow faster thereafter. It does substantially reduce pipe friction and continues to be a worth-while practice.

The A. W. W. A. activated carbon specifications committee have agreed to disagree on how to agree that they are really not ready to report final specifications on this important matter. They have agreed that they should be discharged and their work to date be considered as a workable set of tentative specifications. They argue that more research work should be conducted on this matter. (Probably to give them more facts to fight over and to disagree on later.) It appears that the phenol evaluation test is good for phenols, but not good for algae and that the threshold odor evaluation test for town A is good for town A if used for town A water with odor X, but not necessarily the proper answer for town B, nor for town A with other than odor X.

The chemical world continues its search for the chemical that will "completely deodorize, purify, neutralize and stabilize sewage." Net results to date show this search to properly remain in the same category as the search for the fountain of youth. Compound X remains a "will of the wisp." We continue dependent on the heavy chemical commodies, the price of which per ton is often less than the cost of 100 lbs. of the average specialty.

*Manager, Technical Service Department.

Alum—Mud vs. Water

Fred Stuart has discovered "merit" in the alum insolubles from bauxite impurities and, instead of paying out his good money to take them out of his alum, he is taking in customers' good money for their presence in his "activated" product, thus making more profit for the manufacturer and saving the customer money as well. He thus descends to the same moral plane as other alum manufacturers, who for years have been selling water (water of crystallization) to water plants for good money rather than to pay good money to take it out of the alum. It is all very confusing.

We are now assured that chlorine, which for years has been stated to be an element 99.999% pure, has usually had impurities present as high as 0.2%, but due to improved methods it is now kept to 0.01% maximum impurities. At this time of writing, some wise boys are trying to prove their contention that the 0.01% is not 0.01%, but an entirely different figure. A chemist's greatest pleasure in life appears to be proving that another chemist is wrong, or doesn't know what he is talking about.

Chlorinators Go Modern

The current move for artistry has reached the chlorinators. The belljar has lost its familiar knob, the body its bumps, and the general exterior appearance its heretofore utilitarian reassurance. One is now confronted with machines that are as beautiful in outline as the Empire State Building. Thus the "Lifetime" chlorinator purchased a few years back will shortly be a horrid unsightly thing in the water plant and as outmoded as a 1931 Buick. The prices of these truly beautiful chlorine edifices are as yet a little vague—it is believed that the artists have not yet sent in their bill.

"Algy—Algy!"

Algae continues to occasionally thumb its nose at copper or chlorine and actually welcomes an overdose of ammonia. Therefore, a shotgun dose of all three has been devised to further confound the poor water works man, who more often than not is also meter reader, meter installer, town clerk, bill collector, night policeman, and relief fireman. This has been given the imposing name of "Cupro-Chlor-amination." It is reported to get the algae coming and going. It also will obviously provide more shekels for the copper barons, more business for the entrenched alkali producers, more machines for the healthy equipment firms, and much appreciated relief for the wretched, poverty-stricken chlorine manufacturers.

Better Plugs for the Plugging

The A. W. W. A. is making a determined effort to eliminate the much cussed and discussed fusible plug from chlorine cylinders. They appear to have struck a

snag in that fundamentally this pressure relief member is provided to protect railroad employees and others in case of fire. The evidence is that they prevent the cylinders from becoming projectiles during a fire. Other means of providing this protection appear not feasible. It is believed that the A. W. W. A. Water Works Practice Committee's efforts in this connection will result in a more reliable fusion member, rather than its elimination.

In closing these rather pessimistic observations, I would like to make a plea to all of you for bona fide reports of chlorine accident troubles to your supplier, particularly fusible plug leaks. Your A. W. W. A. committee is sorely in need of incontrovertible facts. A leaking fusible plug, if allowed to continue leaking, will destroy all existing evidence of why it began to leak. It is important that the leak be stopped or sealed or the cylinder immediately emptied and a study made to determine why the leak started. Such reports will result in more dependable equipment from the chlorine producer supplying the cylinders.

Acknowledgment. — The above paper was prepared from notes used in an extemporaneous discussion before the Maryland-Delaware Water and Sewerage Association, May 19, 1938.

▼

MARKING FIRE HYDRANTS NEATLY AND PERMANENTLY

By W. M. Rapp*

Superintendent, Construction and Distribution, Water Department, Atlanta, Ga.

WHEN I was invited to say something on this subject, my thought was, why not get the opinion of the men who are most interested in getting the greatest amount of water in the shortest period of time from a fire hydrant.

With this thought in mind I consulted with Chief O. J. Parker, of the Atlanta Fire Department.

The Chief's suggestions on the subject follow:

The most important information for the firemen is the size of main supplying the hydrant and whether the hydrant is supplied through a 6-inch pipe from the main, also that the hydrant has two 2½-inch connections and one steamer connection with hose threads meeting National Standard Specifications.

The fire department in responding to a fire call would attach the first hose lines to any hydrant nearest the fire, irrespective of the size of main to which the hydrant is connected.

If the firemen knew the size of mains in the vicinity, the pumpers could then be placed in the most strategic position to secure the maximum amount of water available from the mains surrounding the fire.

Scheme of Permanent and Neat Marking

To comply with Chief Parker's suggestions I devised the following plan that will incur a minimum of cost. The accompanying sketch shows the idea.

A projection, or boss, is cast on the cap of the hydrant near the operating nut, and on this boss is stamped in ½-inch figures the size of main to which the hydrant is connected. These figures are stamped with a set of ½-inch hand cut steel dies, the cost of the set being approximately $7.50. This stamping is to be done by the Water Department, as the hydrants are set. All new hydrants set with this marking will be uniformly neat, and will convey the information desired. If the hydrant is removed for any purpose and placed on a main of another size the figures can be filed out and restamped for the size of main to which attached.

All hydrant manufacturers can place this inexpensive boss (projection) on their hydrant patterns. There would be no additional cost in manufacture, and the purchaser would benefit by having this added feature on any hydrant purchased under competitive bidding.

Marking Old Fire Hydrants Already Set

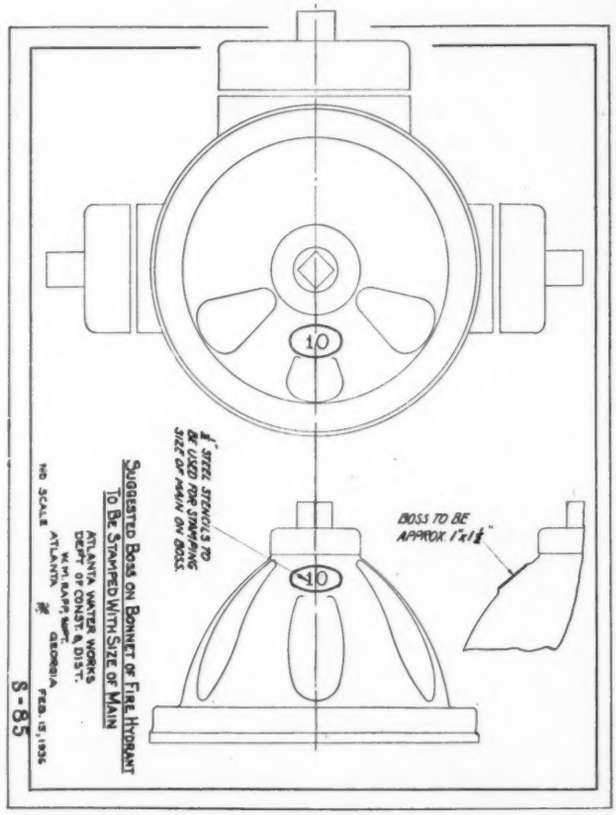
Select a suitable place near operating nut, as shown on sketch. File a uniform flat surface and stamp with ½-inch figures the size of the main. All the tools needed will be a file, hammer and steel figures, and a correct plat showing hydrants and the size of main supplying each hydrant. If the workman is interested it will be a neat job.

This method conveys the required information at all times; once stamped the work is completed permanently at a minimum cost.

It removes any confusion of mind as to the size of main and assures the engineer of pumper the amount of water that he can expect from the hydrant.

It will allow each fireman to become familiar with the size of mains in their district. It will also remove all doubt from the minds of the water works workmen as to size of main in the street.

[The author might have added that in the dark the size of main could be "felt out" with the fingers. At least that could be done in Atlanta, where fingers do not get numbed as easily in winter.—ED.]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10
SUGGESTED BOSS ON BONNET OF FIRE HYDRANT TO BE STAMPED WITH SIZE OF MAIN
½" STEEL STENCILS TO BE USED FOR STAMPING SIZE OF MAIN ON BOSS
BOSS TO BE APPROX 1"x1"
NO SCALE
ATLANTA WATER WORKS DEPT OF CONST & DIST.
W.M. RAPP, SUPT.
ATLANTA, GEORGIA
FEB. 15, 1936
S-85

Marking Boss on Hydrant Bonnet—With Size of Main Stamped Thereon

*The author, a member of A.W.W.A. since 1899, has been recently elected Honorary Member of the Association.—Ed.

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The new and improved Ludlow Sluice Gate shown below marks an advance in modern gate design. Important new features are combined with massive strength and dependability to make this gate outstanding in its field. Wedges at sides, top and bottom are adjustable. Whatever your specifications — for circular or rectangular opening, rising or non-rising type, using any of various types of operating controls—this sluice gate can be furnished to suit your needs exactly.

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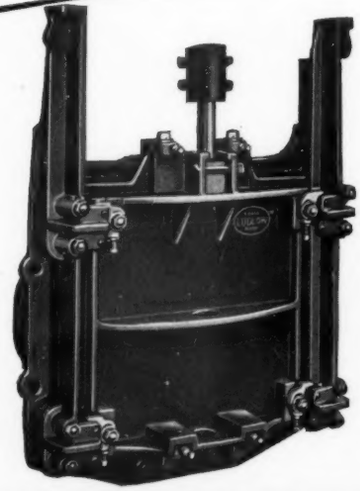
Write for complete information and quotations.



The LUDLOW VALVE MFG. CO.
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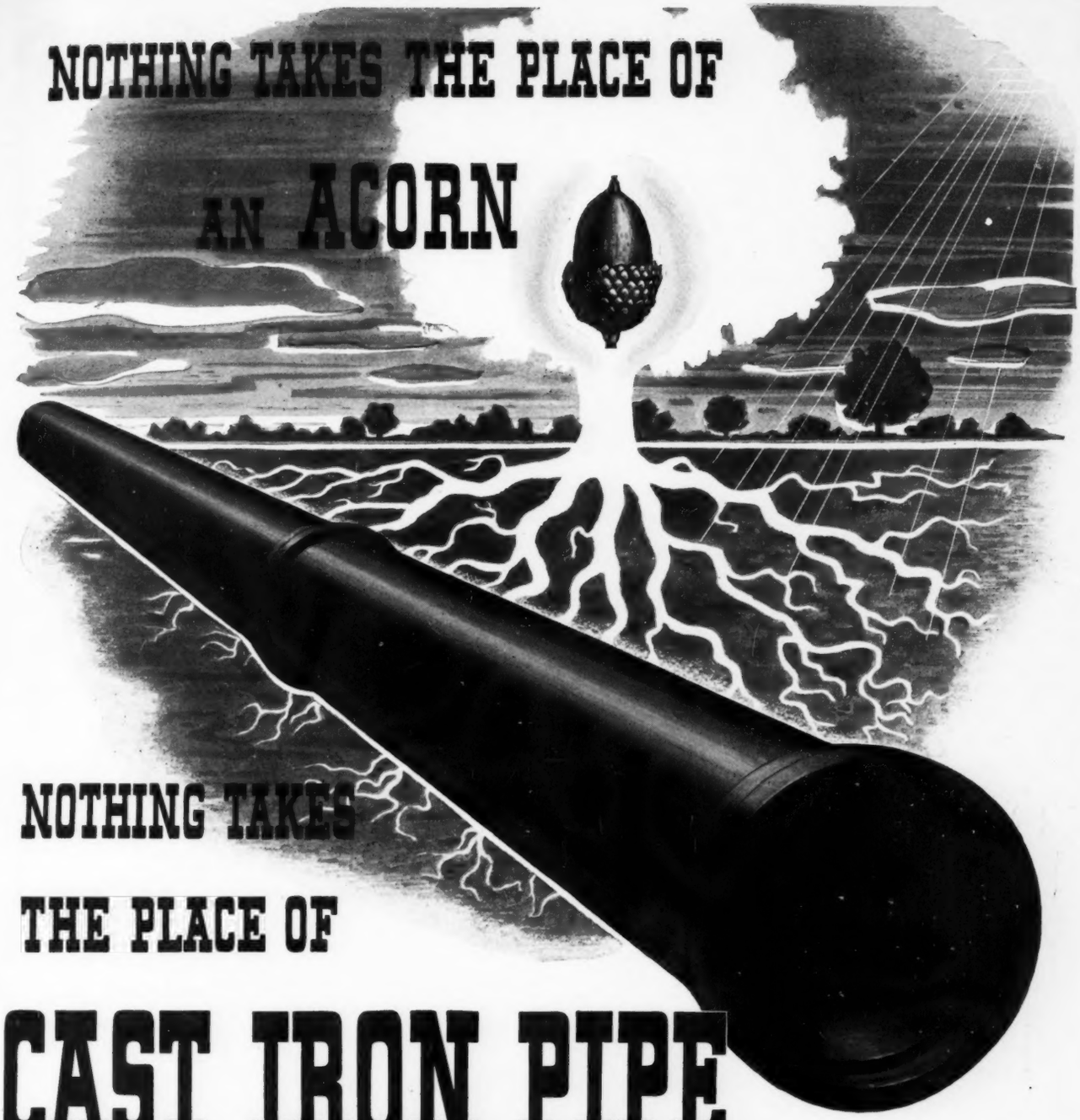

OAK TREES grow from acorns—and *nothing else.* The vast system of cast iron underground mains in America is the outgrowth of a water main constructed in France 274 years ago with cast iron pipe and still in service. *Nothing else,* before or since, has demonstrated equal economy and long life as a material for underground mains.

If you want proved long life and low maintenance cost that result from effective resistance to corrosion—assured safety margins for impact, beam load and crushing stresses—and permanently tight joints—then you will agree that *nothing takes the place of cast iron pipe.* Some materials meet some of these requirements but only cast iron pipe meets them all.

Look for the "Q-Check" registered trade mark. Cast iron pipe is made in diameters from 1¼ to 84 inches.

THE STANDARD MATERIAL FOR UNDERGROUND MAINS

Installing cast iron pipe for water supply project at Antioch, Cal.

THE CAST IRON PIPE RESEARCH ASSOCIATION, THOMAS F. WOLFE, RESEARCH ENGINEER, 1015 PEOPLES GAS BUILDING, CHICAGO, ILLINOIS

"If I were an ADVERTISING MANAGER"•

That's just one of the talks to be delivered anonymously by a masked speaker that will set every man thinking at the Annual Conference of National Industrial Advertisers Association in Cleveland, September 21-23. A second masked speaker will tell what he would do if he were a publication representative.

We're not going to tell you much here—just highlight the program enough to make your mouth water and your brain tingle.

T. M. Girdler, Chairman, Republic Steel Corporation, is scheduled for the opening address and when "T. M." talks he says something.

J. H. McGraw, Jr. will talk on "What I Would Do *Now* If I Were An Industrial Advertising Manager."

The new Publisher's Statement will receive full discussion.

Clinic sessions, so popular last year, will again cover a wide range of interesting subjects. Two half-day sessions instead of one.

A general conference session will cover such subjects as "Preparing the Plan", "How to Gather Usable Material", "Copy Technique", "How to Sell Management", "Co-ordinating Sales and Advertising" and "How and Why to Use an Industrial Agency."

Another session will deal with "Problems of the Small Advertiser", "Production Problems", "Public Relations"—and there are many others.

If I were an Advertising Manager, I certainly would start now to make plans to attend the 16th N. I. A. A. Conference even if I had to hitch-hike to Cleveland. And I would send in my advance registration now to—Ed. Bossart, Bailey Meter Company, Ivanhoe Road, Cleveland, Ohio.

IF I EMPLOYED AN ADVERTISING MANAGER—I would make certain that he attended this Conference, because changing times and markets demand a changed viewpoint—a new viewpoint that can be obtained only by hearing discussions by men whose experience is up-to-the-minute—right up to September 21st.

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SEWAGE SLUDGE INCINERATION*

A Review of Modern Developments and the Status of the Practice

By E. T. KILLAM

Consulting Engr., New York, N. Y.

The Author

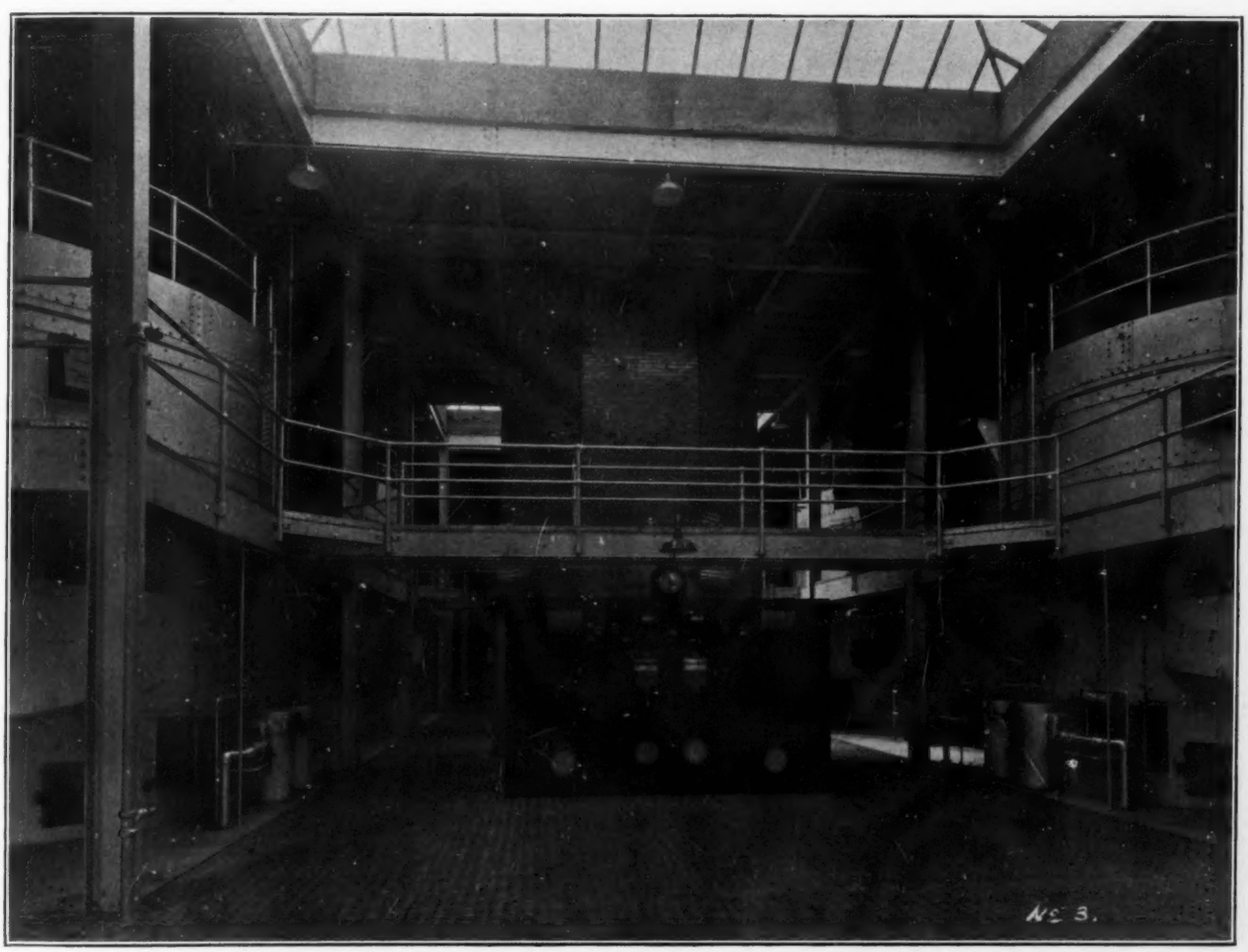
THE problem of adequate and satisfactory sludge disposal has in general constituted one of the most difficult and troublesome phases of sewage treatment. A substantial part of public prejudice against sewage plants may be attributed to conditions resulting from deficiencies in sludge disposal.

The sludge problem ordinarily becomes more serious as plant sizes increase, particularly with respect to the final disposal of the partially dewatered cake. For these reasons the larger cities located on the seaboard have resorted to barging to sea.

*A paper presented before the 33rd Annual Meeting of the New Jersey Sewage Trades Association—March 11, 1938.

While barging has often been established as the most economical of the available tried methods in past years, few engineers are willing to acknowledge that the collection and transportation of material comprising 90 to 95 per cent water, to a point several miles off shore and its dumping into the ocean, is by any means the ultimate goal in sanitation or engineering accomplishment.

Developments in treatment plant equipment during recent years have demonstrated the feasibility of treating sewage essentially without nuisance—in, or adjacent to, closely built up areas. The economic advantages of elimination of long interceptors, and the prevention of deterioration of sewage quality prior to treatment by reducing detention time in interceptors, frequently establishes the desirability of constructing plants relatively close to centers of population instead of at remote locations, essential with some of the older types of plants. The increased



Upper Sections of Four Nichols-Herreshoff Multi Hearth Incinerators at Cleveland, Ohio. (But for the Detroit Installation, Under Construction, It Is America's Most Important Multiple-Hearth Installation. Another Illustration Shows the Interior Construction.)

importance of satisfactory sludge handling under such conditions has, among other factors, stimulated interest in sludge destruction by burning.

Considerations Involved

In summary, the following factors have directly or indirectly focused attention on sludge incineration:

1. Difficulties in the operation of sludge drying beds, particularly during periods of cold weather, heavy rainfall or high ground water; also difficulties from odor and fly nuisance, and restrictions imposed by the development of adjacent areas for residential purposes.
2. Difficulty in obtaining proper sites for the ultimate disposal of partially dried sludge.
3. The long recognized and established heat value of sewage solids, and the fact that after partial dewatering—the sludge, even with a fairly high residual moisture content, will support combustion without auxiliary fuel.
4. Developments in drying sludge for fertilizer purposes.
5. The desire, at many locations, to include in the sewage plant facilities, a positive and complete method of disposal of sludge.

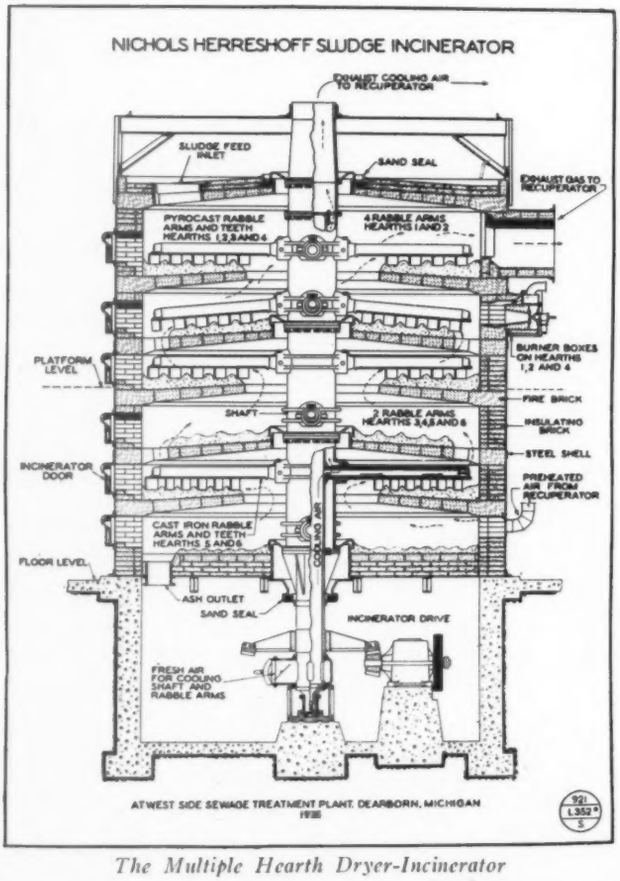
Methods of Sludge Drying and Incineration

Methods of drying and incineration of sewage sludge may be summarized as follows:

(*A*) *Drying* (*For Fertilizer*)
- (1) Without Preliminary Dewatering
  - (a) By Spray Dryer, such as at Plainfield, N. J.
- (2) With Preliminary Dewatering on Sand Drying Beds
  - (a) By Rotary Dryers at Grand Rapids, Mich., and Dayton, Ohio
- (3) With Preliminary Dewatering on Vacuum Filters
  - (a) By Rotary Dryers at Milwaukee, Wis.; Pasadena, Calif.; Houston, Texas

(*B*) *Complete Incineration*
- (1) After Dewatering on Sand Beds
  - (a) By Incineration in garbage-rubbish type incinerator of conventional design, contemplated or tried at a few plants with no known case of routine operation.
- (2) After Dewatering on Vacuum Filters
  - (a) By Multiple Hearth Type Units for drying and incineration in one-step
  - (b) By Flash Dryer and Pulverized Fuel Type Incinerators, including drying followed by optional incineration

(*C*) *Complete Incineration of Screenings*
- (1) After Partial Dewatering in Roll Press
  - (a) In Hand Stoked Modified Garbage and Rubbish Type Incinerators, at Los Angeles "Hyperion" plant since 1934, and at Westchester County Sanitary District Plants since 1930
- (2) After Partial Dewatering in Centrifugal Machines
  - (a) At Milwaukee in hand stoked modified garbage and rubbish type incinerators
  - (b) At Milwaukee and Niagara Falls in multiple hearth type mechanically stoked—since 1937.



The Multiple Hearth Dryer-Incinerator

In addition to the foregoing applications of drying and incineration of sewage sludge and screenings, equipment now available offers a variety of special combinations deserving consideration in certain cases, and depending upon local conditions. Of particular interest are the possibilities in the combined disposal by incineration of garbage, rubbish, and sewage solids.

It is well recognized that the properly designed and well operated garbage and rubbish incinerator of today, will, under normal conditions, produce a substantial volume of excess heat.

There are notable examples of effective utilization of waste heat from garbage incineration in producing steam and power. The production of power, however, creates certain demands which must be considered in design and operation, and economical power production will for some time be limited to plants of substantial size.

An alternate use of such excess heat from garbage incineration (namely, as a means to drive off sufficient moisture from the sewage solids to make the sludge combustible without purchased auxiliary fuel) affords an interesting application of combined disposal.

Incineration and drying of sewage solids has doubtless been retarded due to the recognized item of operating cost, for driving off the moisture in the upper range of moisture content. If heat which would otherwise go up the incinerator stack may be utilized for this purpose, a consequent substantial reduction in operating cost is effected. This saving, combined with other obvious advantages, in many locations, of constructing the sewage disposal and garbage incineration plants at a common site, should make combined wastes incineration worthy of consideration in numerous instances, and the scope of applicability of incineration of sludge will, thereby, be substantially widened.

Inasmuch as the recent installations have been of the multiple hearth type, or the flash dryer and incineration type, these methods will be further discussed in brief.

Multiple Hearth Type Incineration

In 1934 the multiple hearth type incinerator, developed in the mining industry for roasting copper ore, was first applied to the incineration of sewage sludge at Dearborn, Michigan. In this, as in later installations, sludge is partially dewatered on vacuum filters prior to incineration.

The multiple hearth incinerator consists of a refractory lined circular steel jacketed unit, with as many hearths as may be indicated for the specific installation. Rotating plows on each hearth, driven by a vertical hollow air-cooled central shaft, constantly agitate and plow the material during drying and burning. The material drops through staggered openings in each hearth, to the next hearth below, being finally discharged from the bottom hearth in the form of an inert ash.

Multiple hearth installations normally include a blower for producing a supply of cooling air for the hollow shaft and revolving arms, a motor for driving the rabble arms, a rotating motor driven feeder, oil burner installation, and temperature control equipment.

In several cases preheaters have been included in the layout. The economic justification for a preheater, by means of which waste gases are utilized to heat the air supply to approximately 900 degrees F., depends upon the plant size, contemplated daily duration of operating period, and character and moisture of sludge to be burned.

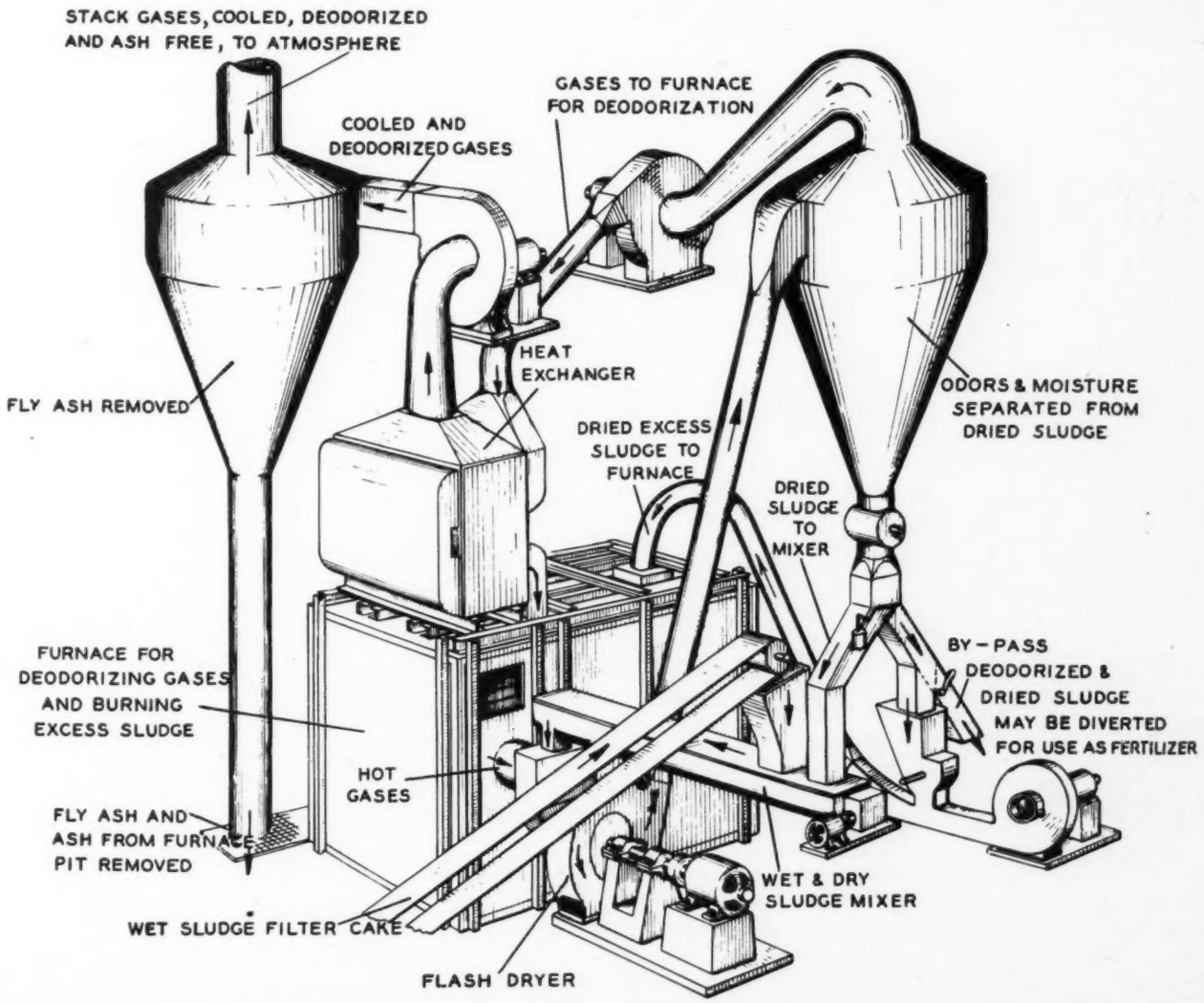
The planned range of temperature at the furnace exit is approximately 1100 to 1300 degrees F. under normal optimum operating conditions.

Beginning with the notable pioneering installation at Dearborn, Michigan, in 1934, numerous installations of the multiple hearth type incinerator have been undertaken. Recent reports indicate that equipment of this type has been, or is being installed, in 21 or more plants at this writing.

Installations at various plants to date vary in size from a single 9 ft. 3 in. diameter unit of four hearths, to the largest installation at Detroit, where four 22 ft. 3 in. diameter, 12-hearth units have been installed. It thus appears that America's largest Multiple Hearth Furnace installation is approximately seventy times the size of the smallest installation.

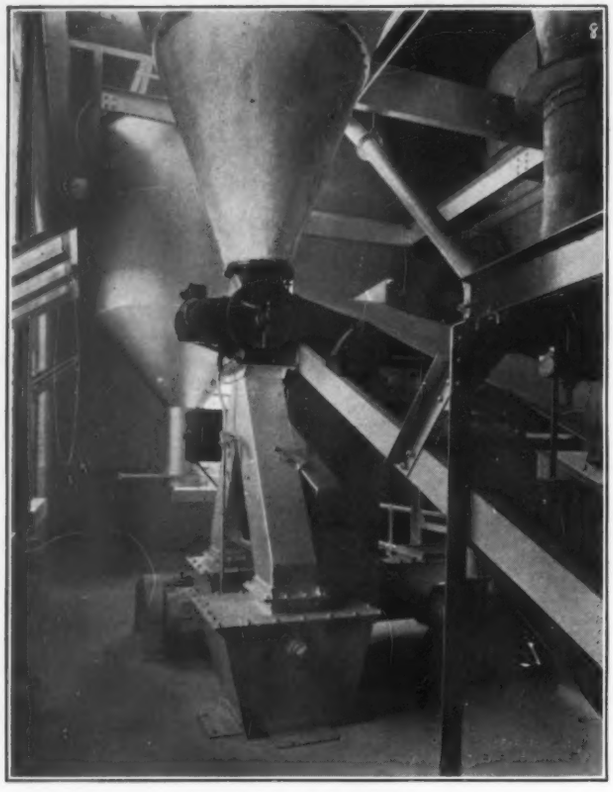
The original Dearborn incinerator handles mixed raw chemical and digested Imhoff sludge, the quality of which is indicated by the fact that the long term average volatile content of the cake fed to the incinerator was 46.6 per cent.

Subsequent installations have been in plants which will


STACK GASES, COOLED, DEODORIZED AND ASH FREE, TO ATMOSPHERE
GASES TO FURNACE FOR DEODORIZATION
COOLED AND DEODORIZED GASES
HEAT EXCHANGER
FLY ASH REMOVED
ODORS & MOISTURE SEPARATED FROM DRIED SLUDGE
DRIED EXCESS SLUDGE TO FURNACE
DRIED SLUDGE TO MIXER
FURNACE FOR DEODORIZING GASES AND BURNING EXCESS SLUDGE
BY-PASS DEODORIZED & DRIED SLUDGE MAY BE DIVERTED FOR USE AS FERTILIZER
HOT GASES
FLY ASH AND ASH FROM FURNACE PIT REMOVED
WET & DRY SLUDGE MIXER
WET SLUDGE FILTER CAKE
FLASH DRYER

The C. E. Raymond System of Flash Drying and Incineration. (This System Makes Permissible Complete Sludge Incineration or a Partial Diversion for Use as Fertilizer. Another Illustration Shows the Cyclone End of the Raymond System in Service.)

Water Works and Sewerage—August, 1938



C. E. Raymond Flash Drier and Cyclone at Neenah-Menasha, Wisconsin. (Note the Split Flow from Cyclone-Separation to the Furnace or to Fertilizer or Dry Sludge Make Up Bins at Will. This is the Type of Equipment Going in at Chicago Also.)

produce sludge of widely varying characteristics, including the following:

(a) Raw Primary
(b) Raw Chemical
(c) Digested Primary
(d) Raw Activated
(e) Digested Activated

Several units have been purchased for incineration of fine screenings and 5 units have been installed with the expressed intention of handling ground garbage along with the sludge.

The operating records developed during the coming year will undoubtedly produce data of wide interest and great value. It is seldom that a development of equal importance in the sewage treatment field has been simultaneously adopted in such a substantial number of plants, involving so wide a variation of operating conditions, as has vacuum filtration and sludge incineration.

As many of the units went into operation late last year and many will start early this year, a very considerable amount of operating data should be forthcoming within the next few months on the Multiple Hearth Sludge Incinerator.

Flash Drying and Incineration

Flash drying and incineration of sewage sludge was first undertaken on a large scale at the West Side Plant of The Chicago Sanitary District in 1933.

This type of equipment involves incineration in two stages—or in other words the drying of the solids to approximately 10 per cent moisture, followed by incineration of the dried material.

The filter cake, with a normal moisture of 75 to 85 per cent, is mechanically mixed with sufficient dried material to develop proper consistency for drying in the flash dryer. Hot gases and this mixture drop into the flash dryer, are violently agitated, and the dried material and vapors are discharged into a cyclone collector. The dried material—approximately 10 per cent moisture—is mechanically divided, a portion being returned to the mixer for blending with the wet filter cake. The balance, or excess, is sent to storage for fertilizer or to a pulverized fuel type of incinerator for destruction, as the case demands. The vent vapors are likewise discharged to the incinerator.

The average design temperature in the dryer is 1100 to 1300 deg. F., and the temperature of the vent vapors varies from approximately 200 to 300 degrees.

The initial installation—at Chicago's West Side Plant, was designed to dry and incinerate raw activated sludge filter cake at 80 to 85 per cent moisture. The rated capacity is 2,000 pounds net dry solids per hour or 8,000 pounds of water evaporation per hour.

Basing the design upon the performance of this unit, equipment was installed at the Calumet Plant of the Chicago Sanitary District and placed in operation in 1935. Three units—each with a capacity of 6,000 pounds net dry solids per hour, or 24,000 pounds of water evaporation per hour, were included. The sludge handled consisted of raw activated filter cake—with small amounts of grit and heavy primary solids from 20 minute detention primary tanks.

In November, 1937, this same type of equipment was placed in service at Neenah-Menasha, Wisconsin, with a capacity of 0.75 tons dry solids per hour, or 3,500 pounds of water evaporation per hour. The sludge at this plant will at times be digested—primary sludge, and at other times will be chemical sludge. A large proportion of paper mill wastes—with high clay content, has at times developed sludge as low as 35 per cent in volatile content.

Similar equipment is now being installed at Buffalo, New York, for incineration of partially digested primary sludge. This plant includes three units each, with a capacity of 5,000 pounds per hour evaporation.

The largest installation of flash drying equipment is in Chicago's notable South West Activated Sludge Plant, where four units—each served by two drying units, with the latter having an evaporation capacity of 20,000 pounds each per hour, are being installed. In this installation power will be generated from combustion of the pulverant dried sludge, with the assistance of auxiliary powdered coal. In this single plant with a total evaporation capacity of 40 tons per hour, combustion engineering has attained a real goal in sewerage practice in America.

The first installation under contract locally, is at Tenafly, N. J., where a small single unit of the drying apparatus, with an evaporation capacity of approximately 0.35 tons per hour, is to be installed, for drying raw activated sludge filter cake and fine screenings, preparatory to the burning of the dried material with garbage and rubbish in an open hearth incinerator of conventional design.

Summary

In summary, sludge disposal by drying or incineration has constituted one of the most active phases of development, in the past few years, in the field of sewage treatment.

While operating data and operating costs for a variety of installations will soon be available, it can be safely stated that careful consideration of the local conditions in each municipality will be necessary in order to approach the most economical solution of the problem.

The variables affecting alternate methods of sludge disposal vary no less than the wide range of requirements

for degree of sewage treatment. In this way, it would appear that a careful analysis of the problem prior to final selection of the method of sludge disposal, will necessitate thorough consideration of the variables involved.

The characteristics of the sludge and moisture and combustibles content vary widely, depending upon the type of treatment from which the sludge originates. The volatile content of various sludges may vary to as wide a range as from 30 per cent of the total dry solids, to 80 per cent, or even higher. While a heat value of 10,000 b.t.u. per pound of dry volatile matter has frequently been used in computation, additional experience indicates wide variations in b.t.u. content per pound of combustibles.

The demonstrated performance in sludge incineration during the past few years, however, has placed this much needed facility in an important position as a method of sludge disposal. The above variables mentioned will not, it is believed, be of sufficient importance to jeopardize the success of the method, but will affect merely the economic advantages of one method or type of incinerator over another, where incineration is indicated as the preferred method.

▼

J. L. Barron, Sanitary, Engr., of Nassau County, L. I.

J. L. Barron, who since 1930 has been Sanitary Engineer of the Westchester County (N. Y.) Dept. of Health, resigned July 1st to accept a like position in the recently formed Health Department of Nassau County, Long Island, with the title County Sanitary Engineer.

Mr. Barron began his career as assistant engineer with the Kansas Dept. of Health and later went to the New York State Department of Health, from which he resigned to take the Westchester County appointment. There, starting alone, he built up a staff of 13 men and just before his resignation a new Sanitary Code for Westchester, drafted by Mr. Barron, was enacted by the County Board of Health. Mr. Barron is Secretary of the Public Health Engineering Section of the American Public Health Ass'n.

In taking his new position, through an interesting coincidence, Mr. Barron is once more under his first superior—Dr. Earle G. Brown, former Kansas Commissioner of Health, and now head of the new Nassau County Department.

▼

3rd Annual Short Course to Be Held at University of Maryland

The third Annual Short Course for Operators of Water and Sewage Treatment Plants will be held at the University of Maryland, Sept. 13, 14, and 15. This course is given with the Md.-Del. Water and Sewage Works Ass'n, the Four States Section of A.W.W.A. and the Md. State Dept. of Health cooperating.

For students attending Short Schools previously, advanced courses have been arranged. The simpler courses for first year men will be given as usual, and emphasized. The total cost for those living on the University grounds (including meals and room for 3 days) is but $7.00. Those living elsewhere will pay only the $3.00 tuition fee.

For a copy of the program and schedule of classroom and laboratory work, or other particulars, write Carl A. Hechmer, Short Course Chairman, care Washington Suburban Sanitary District, Hyattsville, Md.

Ohio Sewage Conference Proceedings Out

The Eleventh (1937) Annual Report of the Ohio Conference on Sewage Treatment is ready for distribution. This report records the transactions of one of the largest and best meetings in the history of the organization, and contains interesting and helpful technical information pertaining to sewage and waste treatment. It includes such papers and discussions as "The Design of a Small Sewage Treatment Plant"; "The Relation of the Part-Time Technical Supervisor to the Sewage Treatment Plant Operator and to the Municipal Official"; "Planning the Organization and Conduct of a Stream pollution Survey."

One especially interesting feature of the report is the "Explanation of the Ohio Regulations for Classification and Certification of Water Sewage Treatment Plant Operators" which went into effect in 1937.

The report has been financed from the treasury of the Conference without aid from advertising, as those of 1935 and 1936. Such has made it necessary to make a charge of $1.25 for the 1937 report, procurable from Bruce McDill, Secretary, Room 302, State Office Bldg., Columbus, Ohio.

▼

"Nalco's" New, Spiffy, Comfortable Home

Sometime ago a brief description of the unique windowless, man—climatized and lighted headquarters, offices and laboratories of National Aluminate Corporation in Chicago appeared in this magazine. In this sort of weather one thinks with envy of dustless and noiseless

"NALCO" House

working quarters where, if you don't like the weather, you can just change it with the turn of a dial within arm's reach in every room.

This picture shows the entrance of "NALCO" House done in washable tile and wrought aluminum. There must'a been Aluminates in "them thar hills"!

A P. W. A. PROJECT OF GEORGE WASHINGTON'S TIME

By R. ALTON JACKSON
Winston-Salem, N. C.

A FEW wooden pipes and one remaining cistern are all that remain to tell of the old Salem, N. C., water system, one of the first established in the United States.

When George Washington visited the little Moravian settlement of Salem, on June 1, 1791, the weather was hot. He paused in a tour of the little village to drink from a cistern in the square. He marveled at the clear, cold water running continuously through the big sunken tank, always fresh, always at the same level.

The citizens, with pride, explained that the water came from springs far up in the woods above town. It was brought down through an underground pipe made of hollowed logs and flowed by gravity through a system of cisterns located at strategic points in the settlement.

The idea of a municipal water supply was nothing new. But the construction of such a perfect system with the tools and materials available was an outstanding example of the ingenuity and craftsmanship of industrious Moravian colonists.

A P. W. A. Project of 1774

No doubt the church officials told George Washington something else which might have interested a 1938 president. For, Salem's water system was a public works project—a revolutionary example of providing employment on public construction in time of economic emergency.

It was started in 1774, before the Revolution, and nearly a score of years before Washington's visit. When the pinch of war hit the colonists and currency was depreciating, the Salem citizens pushed construction of their waterworks, a gigantic task for that day, and helped solve their unemployment problem.

The water for the village came from springs near the present site of Calvary Moravian church in Winston-Salem.* One of these springs still flows today from a culvert. Several of the springs were linked together to furnish an abundant supply and the water was piped down the hill through an underground aqueduct, following a route that would lead through the Main street of Salem. The entire pipe, about a mile and a quarter long, was fashioned of beautifully-fitted hard pine logs, hollowed out by hand (see cut).

*Historic Salem and hustling Winston, N. C., grew toward each other until the two municipalities consolidated as Winston-Salem. —Ed.

The Pipes of Salem—Laid in 1774

The Main Cistern of Old Salem—A Public Water Supply Project of 1774

The sections, five feet long, were about eight inches in diameter and the hole through the center was three and a half inches. To join the pipes, a cast iron ring was driven into the end of one and the next section forced on. Cast iron pipe was not known in those days.

The main cistern (see cut) was located near a present unnamed alley between Bank and Brookstown streets in Winston-Salem and several others were placed farther down the hill to serve all the buildings in the little community. The system was enlarged from time to time as the city grew. Each cistern had an overflow pipe that led to another at the next lower elevation, providing a continuous flow and the water was said to be always fresh and cold.

Construction of the system required four years. It was completed in 1778 and had been so well designed that it served the fast-growing village adequately for half a century. Fifty years later the residents, finding their needs increasing, built another waterworks, this time a pump system. A tiny stream that flows beyond the famous old Moravian graveyard where every year tens of thousands come to hear the Early Easter Services, and a spring, were used as sources of supply.

A large overshot wheel forced the water uphill to a main cistern at the south end of the town from which it flowed in crude earthenware pipes, through the enlarged system. The cisterns were lined with brick and a hand pump was placed on top of each, with connections for a fire hose.

Today the cistern in old Salem square still stands as a lone reminder of the serviceable and practical water system that brought water for the first President of the United States to drink one hundred and forty-seven years ago.

CATHODIC PROTECTION

A Simplified Explanation of Principles and Practices in This Method of Preventing Corrosion of Pipe Lines

By STARR THAYER

Consulting Engr.,
Houston, Texas

In the gas and oil fields many miles of pipe lines, in recent times, have been and are being successfully prevented from suffering deterioration, due to soil corrosion, by application of so-called "cathodic protection." In the water works field cathodic protection was perhaps first applied in New Orleans by Robert Kuhn, as a means of preventing pipe pitting due to electric current flow leaving pipes of the distribution system, taking with it the metal. Such attack is commonly known as electrolysis, whether due to stray man-made currents collecting on the pipe and later leaving it, or whether due to currents set up as the result of the electrolytic cell effects naturally resulting in the process of corrosion of metals.

To most water works men modern cathodic protection, as today applied in the preservation of long and costly cross-country pipe lines, is either new or is scantily understood at best. Therefore, the American Water Works Association invited the author of this paper to discuss the application of cathodic protection in principle and practice, and in simplified language understandable to all alike—including editors. That this expert in his field has done a splendid job of presenting the A. B. C.'s of cathodic protection must be acknowledged by all who read Mr. Thayer's paper presented before A.W.W.A. at its New Orleans Convention, and here presented by permission of the Association.—Ed.

The Author

MANY papers and articles have been published in recent years on the subject of electrically protecting buried pipes lines against corrosion. As this is the first paper of its kind to be presented before this association, we shall attempt to summarize the developments of so-called cathodic protection from its beginning. It is well to state here that this paper will deal only with corrosion on buried or submerged metals. Protection of metals in the air or in fumes is effected in a different manner.

Before we can intelligently discuss this subject of protection we should understand the causes of corrosion. For convenience we may divide the causes of loss of metal into three classes.

1. Electrolysis

This is generally referred to as meaning the loss of metal caused by man-made stray currents. This condition would exist in cities having street railways, for instance. The remedy here, of course, is to install the proper drain wires to carry these currents back to their source instead of allowing them to pass off into the soil. This problem has occurred so often that it needs no discussion here.

2. Long Line Currents

It has been found that when long pipe lines are built, currents will often be found to be entering the pipe at some places and to be discharging into the soil at others. These currents are always relatively small. It is not probable that these currents in themselves cause much trouble. Probably the other causes of corrosion will be so much more severe that the effects of the long line currents will not be measurable.

3. Soil Corrosion

Soil corrosion is the most common and most destructive of the agencies which attract buried metal. The causes of this corrosion are primarily due to the composition of the surrounding soils. The relation of corrosion to soil analysis is in itself a large subject for discussion. Briefly, it may be stated that the more common factors that make a soil corrosive are moisture and salt content of the soil, its acidity, electrical conductivity, and oxygen. These are but a few of the causes. However, it is not the purpose of this paper to discuss the causes of corrosion, but rather to review a means of stopping it.

It is common practice now in building new lines to coat the pipe with a protective material. If this material is properly selected and applied, and does not suffer damage or rupture later, the losses due to corrosion may be almost, if not completely, eliminated. It is the existing lines, or lines laid in the past, or modern lines which may develop weak spots later, that are the chief concern of the operator. To remove and repair or replace such lines is naturally a very expensive operation, and it is with these lines that the use of electrical protection is most justifiable.

Cathodic Protection

It has been proved that regardless of the cause of the corrosion on the pipe, the action is the same. Currents are generated in the pipe itself. These currents flow in the pipe wall to areas where they discharge into the soil. This is illustrated in Figure 1.

As they leave the pipe they take metal with them. These currents are very small but they may be and generally are discharged in small areas. When it is realized that one ampere leaving a pipe wall will take twenty

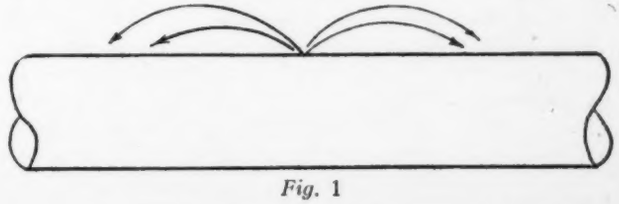


Fig. 1

pounds of metal with it within a year, it is seen that a very small part of an ampere will do much damage when confined to a small area.

An "Electric Dam"

The principle of cathodic protection is simply this: a current is caused to flow from the surrounding soil onto the pipe wall in sufficient strength to block these currents which are trying to leave the pipe. When this is done corrosion will cease. To make this a little plainer, suppose that it is water which is flowing through pinholes in the pipe wall and off into the soil. If it were possible to build up a pressure in the surrounding soil of sufficient intensity then there would be no more water to leave the pipe. Of course, that is impossible but it is possible when dealing with electrical pressures to do the equivalent.

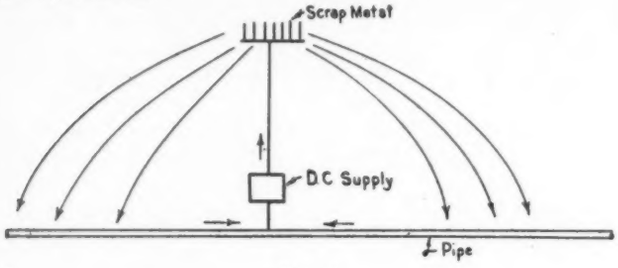


Fig. 2

To cause the current to flow onto the pipe wall, it is necessary first to have a source of direct current. The positive terminal of the source of D. C. current is connected to a mass of junk iron buried in the soil not far from the pipe to be connected. The negative terminal is connected to the pipe. Fig. 2 illustrates the circuit.

As the current is forced from the scrap metal, it passes through the soil and onto the pipe and is returned through the wall of the pipe and the connecting wire to the source of the current.

Equipment

Now, this is a simple circuit but its application proved not so simple. First, it was necessary to obtain the source of direct current. The current required is of low voltage and rather high amperage. Rectifiers, which change alternating current to direct current, were first used where purchased power could be obtained. Motor-generators were also used to some extent. Where power was not available, engine driven sets have been used with considerable success. This has been the case particularly with natural gas lines because fuel to operate the engines can be taken from the line at any desired point. In many locations, wind driven generators have been successfully used. The development of these different types of generators has been rather slow but, at the present time there are many makes of each type on the market.

How Much Current Flow?

One of the first studies made was to determine what was necessary to stop the corrosion. After many tests and experiments, it was found that if the pipe was approximately 0.3 of a volt negative to the soil that corrosion would cease. In other words, if we have a pressure in the soil of 0.3 of a volt above the voltage of the pipe line, we have accomplished our purpose.

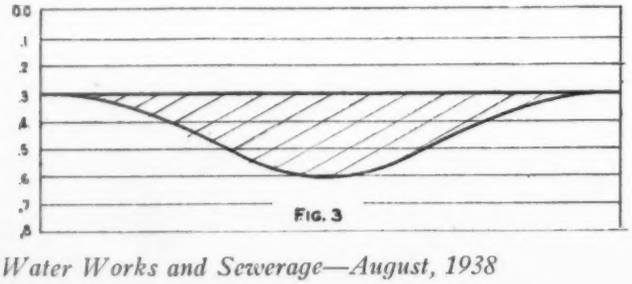


FIG. 3

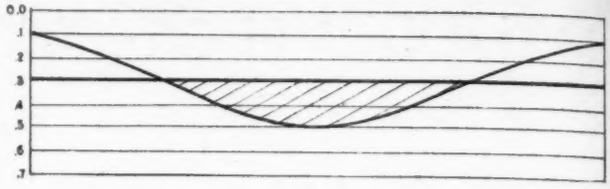


FIG. 4

After the current is applied to the line it is necessary to be able to make tests which enable the engineer to determine the effectiveness of the installation. This is done by measuring the difference in voltage between the pipe and the soil at intervals along the line. To obtain these readings accurately, it is necessary to use a high resistance volt meter and a special terminal to make contact to the earth. Such meters and terminals are now on the market.

Practical Application

Referring to Fig. 2, it is seen that when the current enters the pipe from the soil, it must have a free path back to the generator. This necessitates the bonding of all insulating couplings or fittings in the line. This bonding consists in welding or brazing a comparatively large wire around this fitting to carry the current past it. When this is done and the current is turned on, voltage readings are taken between the pipe and the soil. These readings may be plotted to better observe the effects of the protection. Fig. 3 is a typical illustration.

In this case, the protection is limited to a definite area, and the coating and soil were uniform.

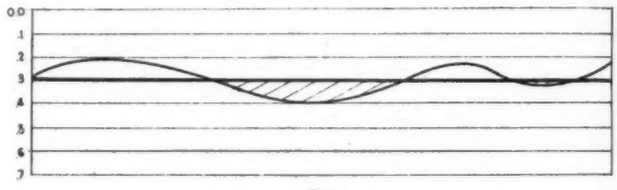


FIG. 5

Fig. 4 illustrates the effect of applying the current to an unlimited area.

In this case, it is seen that some protection is secured for a considerable distance beyond the area of *complete* protection.

Fig. 5 illustrates a condition where there are considerable changes in the soil and condition of the protective coating.

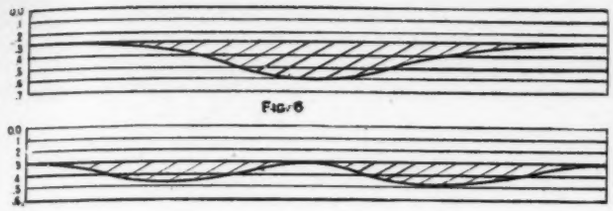
In each curve a line is shown which represents no difference in voltage between the pipe and the soil. Also, a line is shown which represents the amount of voltage necessary for complete protection. The area below this line and the curve is, of course, wasted power. However, this is necessary to secure the protection required at the ends of the area.

Power Conservation

Fig. 6 illustrates an actual application on uniformly coated line laid in a uniform soil.

The top curve represents the protection secured on four miles of line from one unit. The lower curve shows the protection secured on four miles, but from two units. The amount of wasted power, as represented in the shaded area, is much less in the lower curve.

These units are of the rectifier type, so the current requirements are easily measured. The effect of this wasted power is shown, as follows:



The large unit required 60 amperes at 9 volts, or 540 watts. The combined smaller units required 24 amperes at 3 volts, or 72 watts. From this, it is seen that for economical operation several smaller units are better than fewer large ones. However, circumstances and first costs must be considered. In other words, each installation is a separate engineering problem. The writer has installed at least two units with an output of over 100 amperes. In these particular instances, such units were the most economical to install.

How Much Line Per Unit?

Now, a question that is sure to arise is, how much line can be protected with one unit? The answer is, that this is variable and depends to a large extent on the coating. For instance, a well coated large line may be protected for five or six miles with a medium sized unit, while a poorly coated or bare line would only be protected for less than a mile with the same unit. The reason for this is obvious. Where there is a film of coating the current cannot enter the line, hence not so much is required.

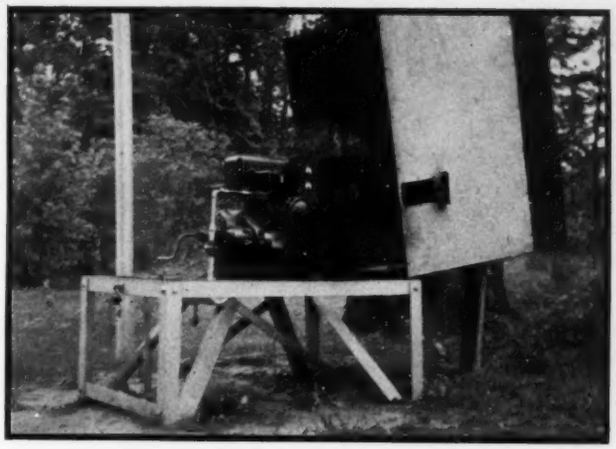
Another question which will be asked is, how much it costs to apply the protection? This, again, varies considerably. In any case, except for very small lines or very short sections, it will be found that the cost of electrical protection will be from five to ten per centum of the cost of renewing the line.

The question may also arise as to whether the application can be applied to distribution systems. The answer is "yes," in many cases. However, the application here is much more complicated on account of other underground structures, which must be considered.

History

Electrical protection was first applied to a pipe line by the writer during the summer of 1931. Since then, it has become recognized by practically the entire pipe line industry as a practicable means of combating corrosion.

Papers on the subject have been presented at nearly every convention of the American Petroleum Institute and the American Gas Association since 1932. It is used, at least to some extent, by nearly every major pipe line company, both oil and natural gas.



Gas or Gasoline Driven Unit Protected by Simple Dog House.

It has been found by corrosion engineers that the rate of leaks occurring on a pipe line, or pipe line system, will form a logarithmic curve when plotted. From this, it is possible to predict accurately leak frequencies in the future. Such a curve was plotted, as shown in Fig. Fig. 7.

The heavy line indicates the leaks as they had occurred up to the time the protection was installed. The dotted line illustrates the number of leaks that would have occurred had the protection not been applied. The broken line shows the number of leaks that did occur after the protection was installed. This curve is based on the data secured from some fifty installations and is the best available proof of the effectiveness of this protection.

Conclusion

No doubt, there are many reasons why the subject of this paper has never before been discussed by this body. Probably, one of the reasons is that so much of the water piping installed has been of cast-iron. However, with the advent of large steel lines this subject will be given more consideration.

This form of protection has many possibilities other than in its application to pipe lines—possibilities where it may be used advantageously. Well casings may often be so treated. Large steel tanks have been protected against corrosion, both on the outside and the inside. The writer made one rather unusual application in protecting the inside of four large centrifugal pumps. This is cited as an example of the possibilities of cathodic protection for combating corrosion.

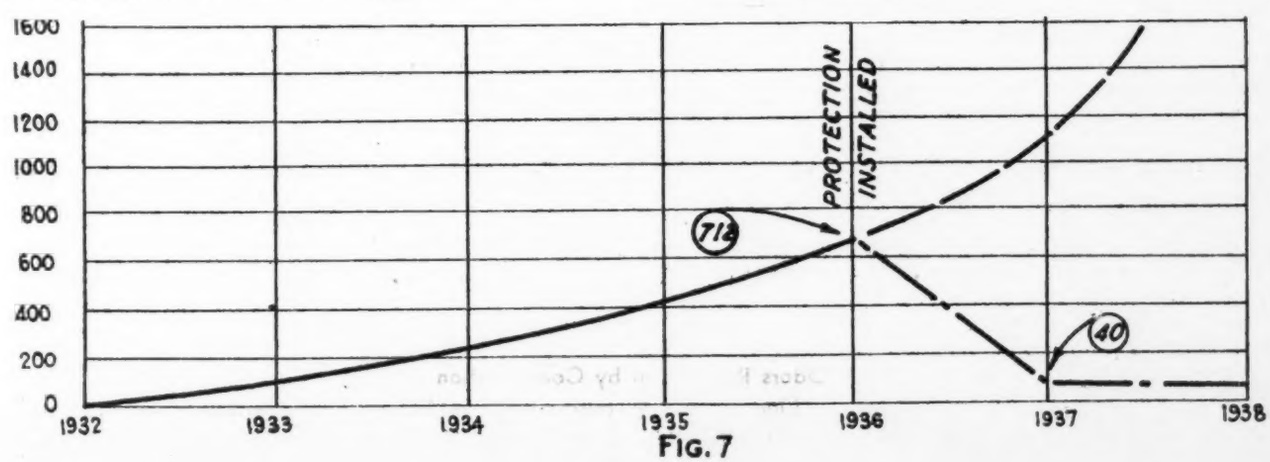


FIG. 7

ACTIVATED CARBON APPLICATION EFFICIENCY*

By MARSDEN C. SMITH

Engineer of Water and Electricity, Richmond, Va.

The Author

THE value of activated carbon has now been demonstrated in water purification so completely that no further data are needed to prove this value. Even the secondary benefits resulting from its use are generally known to the water purification profession. There remains, however, much difference of opinion as to the most efficient method of using carbon for taste and odor removal; and the purpose of this article is to direct attention to this fact.

It may as well be recognized that the use of activated carbon for taste and odor removal (hereafter to be referred to only as odor removal) is not a very simple problem. The nature of the odor producing materials and their adsorption by the carbon vary not only in different plants, but in many plants they vary almost from day to day. The carbons themselves may vary widely in character; one powerful in removing one impurity may be of but small value in removing impurities of a different nature. While not realized by many, the degree of water preparation for filtration (mainly coagulation and settling) has a marked influence on the effectiveness of the odor removal in itself, as well as an effect upon the ability of the carbon to reach and to remove the odors present.

This article will not be composed of statistics and curves which can have no more than a limited interest, and which in fact may well be misleading. It will, instead, suggest certain ideas for investigation; with the assurance that if followed they may produce surprising results.

Evaluation of Results

The most reliable method of evaluating the results of carbon application yet devised is the so-called "Threshold Test." It is simple to use and gives a fairly accurate and rational evaluation.

Since much that follows is founded on results revealed by this test, its technique is now briefly described. Odor-free water is obtained by the repeated filtration of distilled water through a carbon filter. A measured quantity of the water under test is diluted to 250 c.c. with the odor-free water, and then heated to approximately 65 deg. Cent. in an erlenmeyer flask. Usually, three different dilutions of the sample and 250 c.c. of the odor-free water (the latter for odor-free comparison) are heated simultaneously. That dilution containing most of the water under test which produces *no odor* is used to calculate the "Threshold Odor" of the sample. The "Threshold Odor" is numerically determined by dividing the total quantity of water heated (usually 250 c.c.) by the number of c.c. of the sample used.

Odor Limits

However desirable it may be, in actual plant practice it is not often economically feasible to completely remove all odor. This is because, in the first place, it is generally not necessary, and in the second, because odors are adsorbed in direct proportion to their residual concentration. This last statement means that the less the remaining odor the more carbon that is required for a further reduction. As a reasonable limit, it is significant that waters having a threshold odor in excess of six (6), as determined by the above method, are likely to be objectionable to those not accustomed to the supply. Some have found that an odor as high as ten (10) to be not objectionable, although this is probably greater than should be permitted.

Point of Application of Carbon

Where plant design makes it possible to do so, some have found that applying carbon before any other treatment is preferable. This is probably true, particularly in lime softening plants, when thorough mixing and adequate contact time for the carbon to do its work before coagulation, exist. But even in these relatively few plants, apparently not enough study has been made to conclusively prove that such practice is the most efficient and economical.

Most water purification plants were built prior to the introduction of carbon to water treatment, and in most of these the carbon must be applied either shortly before coagulation, with the coagulant, or after coagulation. A recent survey indicates that a large majority of water works engineers believe that carbon should be applied to the untreated water just *before* coagulation. Some few are equally convinced that carbon should be applied only *after* coagulation; and some radicals even add the carbon so that it may go directly to the filters. This article is by one of the radicals who here advances reasons to justify the thought that carbon applied at the filter is a most effective and economical practice.

Coagulation Losses

Coagulation is known to be a progressive phenomenon, that is the floc builds up in size from a molecular structure to the final visible floc, much in the sense that a rolling snowball increases in size. In building up it envelops within its structure colloidal and suspended materials. If carbon is added with the coagulant, some of the carbon is also enveloped in the floc. This must limit or prevent some of the carbon from performing its intended function of adsorbing from the water its undesirable odors and odor-producing materials. Hence it seems evident that the full efficiency of the carbon cannot be obtained with this practice of partial occlusion in the precipitate, removable in the sludge.

Odors Removed by Coagulation

One main purpose of coagulation is to remove impurities from the water. When the well formed floc settles to the basin floor it carries with it much of the

*A paper presented before the American Water Works Assn. at the New Orleans Convention, April, 1938. Here reproduced by permission of the editor of the Journal.

odor-producing impurities and may even adsorb some of the existing odorous materials. And so, if carbon is applied after coagulation has removed a fractional part of the odor and odor-producing materials from the water, the carbon will have just that much less burden and a consequent increased efficiency when used after coagulation.

Filter Coating

Most students of odor removal now agree that when carbon is added *before* filtration, enough must be used to pass through the coagulation basins and to form a film of carbon on the filters. Even with the finely divided carbons now available, by the laws of chance and of diffusion, it is possible for many odorous substances in the water to escape contact with carbon particles when in dilute suspension, and thus pass on into the finished water. On the other hand, when there is a film of carbon on the filters, these odorous substances in the water cannot pass without a most intimate and scrubbing contact with the arresting carbon. Perhaps this explains why the value of a "slight film" on the filters is referred to by many of those who apply carbon before coagulation.

The Effect of the Hydrogen Ion

Consider next, if you will, another peculiarity of activated carbon; that it is more efficient with neutral and acid solutions than in solutions that are strongly alkaline. In most plants the chemical reactions occurring at the time of coagulation reduce the pH of the water, thus the water becomes more acid after coagulation than before. Since this is generally found to increase the efficiency of odor removal by activated carbon, we have another fact indicating the most efficient point of application to be that following coagulation, or after recarbonation if it be a softening process.

Sludge Stabilization

Sludge stabilization is advanced as a benefit to be derived from adding carbon to the water before coagulation. Carbon has virtually no preserving ability, hence it can be effective only in adsorbing gases after putrefaction has occurred. This then proves that a considerable amount of adsorptive capacity of the carbon was unused when it was precipitated with the sludge. This unused capacity is then a true loss so far as odor removal from the water being treated is concerned. Asking pardon for digressing: Where it is possible to use pre-chlorination, is it not preferable to antisepticize the settled materials, rather than to allow putrefaction to occur and then adsorb the gases?

Prechlorination

Prechlorination has so many advantages that many would adopt the practice except for the intensification of tastes and odors that sometimes is a result of "sketchy" prechlorination. It would, moreover, surprise many of those who fear this consequence to know that in many plants this intensification of odor does not constitute a *net* increase. By this is meant that, while a plant odor survey may indicate a marked increase immediately after the chlorine is added to the "raw" water, the same amount of carbon will give as satisfactory or perhaps even a better odor reduction in the finished water than is obtained when prechlorination is not being used. May not the explanation be that chlorination before carbon application has made the odorous materials as much easier to absorb as it has made them more pronounced. And also, since chlorination must be used at some stage of purification, the residual offensive materials, even after filtration, are sufficient to cause an equivalent intensity of odor in the finished water, unless removed by an increased amount of carbon before being intensified by post-chlorination.

Filter Runs

Those who apply carbon after coagulation or to the filters, often suffer a reduction in filter runs. Even such a valid argument against this practice loses much of its force in the face of some pertinent facts. In Richmond, where carbon is fed directly onto the filters, runs often exceed three hundred hours; the annual average always more than one hundred hours, and wash-water required one percent or less. When organic growths in the filter beds tend seasonally to increase so much as to shorten filter runs, an increased amount of carbon is now known to materially lessen their effect. Several observers report that not only is this true, but carbon application onto the filters at such times actually increases the filter runs. However, let it be admitted that where preparation for filtration is deficient, resulting in short filter runs and bad filter condition, carbon application in excess of ten pounds per million gallons (the probable equivalent of as much as seventy-five to one hundred pounds if used before coagulation) may be impractical.

Batch vs. Continuous Feed

A considerable study has been made to determine the relative efficiency of adding carbon *continuously* to the coagulated, settled water as compared to applying the carbon in batch at the beginning of each filter run. The first of these plans involves adding sufficient carbon continuously at a rate found sufficient to reduce the finished water odor to the pre-determined value. The second differs by placing a relatively large quantity of carbon in the filter box just before refilling after washing the filter. It has been found that each method has its advantages. The continuous feed is simpler, but often allows an unsatisfactory water to pass at the beginning of the run. That is to say, until a sufficient carbon coating is deposited on the filter to become effective as a barrier against the passage odors. On the other side, it is true that the batch feed must be renewed if the filter run continues until the adsorptive capacity of the first application of carbon is exhausted. The time for this renewal is variable and must be determined by test after a number of hours of a filter run, if the maximum efficiency is to be obtained. But, equally variable is the quantity needed for the maximum efficiency when the carbon is applied continuously. In Richmond the batch feed is preferred because for equivalent results, approximately 15% less carbon is required than for the continuous application. And here we first apply sufficient carbon for twenty-four hours run at the beginning of the run, reinforced every twenty-four hours after by adding the same quantity of carbon. It is recognized at Richmond that there is a practical limit to the quantity of carbon that may be applied directly on the filters, hence the plant is equipped to add carbon to the raw water at any time an emergency may require this less efficient added treatment. The maximum quantity of carbon that may be applied to the filters is empirically limited to ten pounds per million gallons. However, so long as the coagulation results are the Richmond normal, even this low limit is never used. Again asking permission to digress, it seems that here again we find proof that if coagulation is right all other operating problems are reduced, if not eliminated.

Conclusion

It is hoped that what is here recorded may be taken not as a provocative discourse, but rather as an incentive to further study of the problem of most efficient use of

carbon. Certain it is that it would be a great loss to Richmond should it become necessary to apply carbon before or with coagulation. Due to the splendid results with an average quantity of less than five pounds per million gallons, it is now economically practical to apply carbon the year around. But, were it necessary to apply carbon before coagulation, since that practice has been proven by repeated tests to require more than ten times as much carbon as when applied to the filters, carbon could then be used only during emergencies. This would be most serious since the bad odors that would pass before the emergency was recognized would ruin the reputation and impair the public confidence in the water supply; and this impaired confidence, we all know, would persist long after the emergency had passed.

A DISCUSSION[1]

By John R. Baylis*

Although many are under the impression that some certain grade of carbon is much better for their particular odor problem than some other grade, even though the two materials have equal phenol adsorption values. Such selectivity has not been observed by the writer, and the phenol test has given reliable results in all types of odors which have been encountered in water.

While in agreement with Mr. Smith that the odor threshold test is the most assured means of determining the effectiveness of carbon treatment, it is believed that a hot threshold odor of 6 is too high for a finished water. The upper limit should be 4 and for assured relief from complaints, a hot threshold odor of 2 is far safer practice, and produces the quality of water the consumer should have.

Concerning the savings made possible by adding the carbon to the filters by the batch or flush-in method, the Richmond results are both interesting and surprising. Based on experience others should not expect that a like reduction in carbon required can be realized by the flush-in scheme, if applied at their plants. The writer's belief is that, in general, the average economies which may be effected by applying the carbon directly to the filters will be about 10 to 20 per cent, instead of 90 per cent as found at Richmond. Naturally there will be a few places varying all the way from 20 per cent to 90 per cent.

Apparently the Richmond water is one wherein a substantial quantity of the odor is removed by coagulation and sedimentation. [Mr. Baylis might have added—"and the very heavy (super) pre-chlorination dosage employed in conjunction with long contact period."—Ed.] In most waters, however, very little odor reduction can be attained through coagulation and settling. Observation would indicate that one may expect 10 to 20 per cent reduction in the odor by coagulation, sedimentation, and filtration for the average water. Should the hot odor threshold be 12 and it is desirable to reduce it to 2, we are confronted with the practical operating fact that not enough carbon can be added directly to the filter to produce this reduction.

There are not many waters where less than 0.8 ppm. carbon may be used for each unit reduction of the hot threshold number, usually more than 1 ppm. per unit reduction being required. It is possible to add a part of the carbon in the beginning and part to the filters, and possibly make some saving. Such a saving on the average might amount to 10%, and 20% would be the maximum saving expected.

[Mr. Baylis presents data from carefully controlled laboratory studies to prove his belief that neither the method of applying the carbon, or point of application, has any material bearing on possible economies in carbon dosages required. These comparisons, however, did not include tests involving the batch or flush-in method. This Mr. Baylis pointed out as lacking.—Ed.]

It is hoped that these remarks will not be taken to reflect on the work and results attained at Richmond, and based on actual operating experiences. The purpose is to point out that such savings as reported at Richmond, or even comparable savings, should be expected in only a few places.

(1) Excerpts from a prepared discussion by Mr. Baylis.
* Physical Chemist, Dept. of Public Works, Chicago.

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Mellon Institute Studying Acid Iron Waste Problem

Prof. W. W. Hodge Heads the Work Financed by Steel Industry

A problem of magnitude is that of reducing stream pollution by waste liquors from the process of acid-pickling of steel and iron. The iron and steel industry has been put to heavy expense for many years in handling and neutralizing these acid wastes. Now it has founded, through the American Iron and Steel Institute, a fellowship at Mellon Institute of Industrial Research (Pittsburgh) for the purpose of studying the problem in an attempt to define a solution just as soon as possible.

An objective will be to treat or process the waste liquor of steel pickling plants so as to render it entirely safe for discharging into streams. Secondly, there is hope of recovering from such wastes certain chemicals from which useful products can be made economically. Thousands of tons of iron and sulfuric acid, representing a continuing loss, are now wasted annually by steel mills and steel product manufacturers of this country.

Professor Willard W. Hodge, since 1921 head of the Department of Chemical Engineering at West Virginia University, and also director of the W. Va. Engineering Experimental Station, has been granted a leave of absence to head this investigational work at Mellon Institute.

(We feel certain that any and all available knowledge pertaining to possibilities in connection with the treatment or recovery of material from iron acid-pickling wastes will be welcomed by Professor Hodge and Mellon Institute. There may be "gold in them thar wastes" —at least we hope so.—Ed.)

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TO THE CATLETTS

Our Apologies

With the report of the 1938 Florida Short School and meeting of the Florida Section of A.W.W.A., in our July issues, on page 685 appears a strip of pictures a part of the caption of which was dropped. On the right end is a none too flattering picture of a most attractive un-named lady and a dangerously handsome husband. All Floridians know that these are the George Catletts of Jacksonville. (Others may have guessed as much because George's picture, as State Sanitary Engineer, appears properly labelled nearby. We regret this omission and to the Catletts our deep apologies.—Ed.)

LABORATORY AND FIELD STUDIES ON CHLORINE DEMAND OF SEWAGE

By G. E. SYMONS[1], G. E. TERHOEVEN[2] and W. L. TORREY[3]

Buffalo Sewer Authority
Buffalo, N. Y.

Dr. G. E. Symons

THE Bird Island Laboratory of the Buffalo Sewer Authority was established in April, 1936, to study sewage characteristics in the city and to make the data available to Greeley & Hansen, designing engineers of the new Buffalo sewage treatment plant.

One of the major phases of the laboratory work has been the study of chlorine demand by laboratory research and field studies. Many variables involved in this problem, including temperature, population tributary, industrial load, variations in concentrations of sewage, age of sample, contact time, bacterial reduction, et cetera, were investigated. The technique of sampling and test procedure employed is believed to offer an improvement over any heretofore reported. A mass of pertinent information has been collected and it is the purpose of this paper to report the most important of these data.

Determination of the Chlorine Demand

During the early studies in the summer of 1936, it was observed that samples of sewage which had been refrigerated overnight had a lower chlorine demand than fresh samples. On standing at room temperature, the chlorine demand of the samples increased. Compositing of 24 hour samples gave low results. In the larger sewers, it was found from field studies that the chlorine demand changed rapidly within periods of 15 to 30 minutes. Because of these factors, special sampling and analyzing procedures were established.

Each sewer was sampled and the flow measured by gaging every 15 minutes. At the end of each two-hour period, these samples were delivered to the laboratory, where they were composited proportionally to the flow, and the chlorine demand was determined on such composites. Tests indicated that compositing samples averaging one hour in age did not affect the chlorine demand.

[1]Chief Chemist, [2]Analyst, [3]Assistant Analyst.

From the flow and the analysis of the composite, the chlorine demand rate in pounds per day was calculated for each two-hour period. These two-hour period demand rates were averaged to give the total chlorine demand in pounds for the day. Since the regulation of chlorinators is generally by rates per 24 hours, the data are reported in pounds per day as well as parts per million. To obtain these rates per 24 hours throughout the day, the two-hour rates were plotted as a step diagram and a curve was drawn through these steps.

The temperatures for the 192 individual samples each day were averaged. Bacterial analyses were made on the raw and chlorinated two-hour composites. Due to lack of space these will be reported in a separate article[11] to appear in this magazine at an early date.

For the actual determination of the chlorine demand, a modification of the Standard Method[8] was used. The so-called Bird Island Laboratory method has been reported in a paper by one of the authors[10] and will be only briefly reviewed here. Data presented showed that the ten-minute contact period used by Rudolfs and Gehm[7] actually reveals only 92 per cent of the total chlorine demand [when above 6 p.p.m.] at 20 deg. C.; and only 88 per cent if determined at 8 to 12 deg. C. Below 5 p.p.m. the ten-minute contact time appears sufficient. After 15 minutes' contact there was no further appreciable uptake of the available chlorine (residual) present.

It was found that the temperature at which the test is run is not important between 8-25 deg. C., though above 10 p.p.m. the demand at 20 deg. C. is about 4 per cent higher than at 10 deg. C.

Above 3 p.p.m. residual the color endpoint develops maximum intensity in the ortho-tolidine test in 30 to 45 seconds and fades thereafter. To obtain 0.1 p.p.m. residual, after a period of five minutes' standing with ortho-tolidine as recommended,[8] requires 10 per cent more chlorine in the dosage (i.e., the chlorine demand as determined by the standard method is 10 per cent higher than that determined by the Bird Island method for a residual of 0.1 p.p.m.; higher residuals will require even more).

The investigation of basic principles in any science may produce two results. One of these is the application of information to the solution of an immediate problem; the other is the subsequent effect of this same knowledge as applied to related problems.

Establishment of an adequate laboratory by the Buffalo Sewer Authority has enabled the city to supply data fundamental in the design and economics of operation of the world's largest sewage chlorination plant. The wisdom and economy of this study is immediately apparent, and more such preliminary technical surveys could be used to great advantage by designing engineers and city authorities.

The eventual value of the extensive and thorough survey of chlorine demand, and of chlorination economics, reported in this and the companion paper to appear soon, bids fair to be much greater than its present application.

In a forthcoming paper, Dr. Symons and his associates report accomplishments in bacterial kill, under various chlorinating procedures, and set forth reasons for the adoption of prechlorination of Buffalo sewage, as a year 'round procedure.—ED.

TABLE I

Chlorine Demand of Domestic Sewage

Hours	Flow C.F.S.	Chlorine Demand p.p.m.	Chlorine Demand Rate/Day Lbs./24 Hrs.	Chlorine Demand Pct. of Average
6- 8 a.m.	4.88	1.1	29	18
8-10 a.m.	6.51	5.4	185	115
10-12 a.m.	7.00	7.7	294	182
12- 2 p.m.	6.99	9.9	372	231
2- 4 p.m.	7.01	6.1	227	141
4- 6 p.m.	6.70	5.7	207	128
6- 8 p.m.	6.94	3.0	112	70
8-10 p.m.	6.74	3.2	118	73
10-12 p.m.	6.15	3.7	123	76
12- 2 a.m.	5.93	3.4	108	67
2- 4 a.m.	5.38	2.9	94	59
4- 6 a.m.	4.90	2.3	60	37
Average	6.75	4.5	161	100

Population tributary—34,600.
Chlor. Dem.—Lbs. per capita per day—0.00466.
Flow per capita—120 gal. per day.

The endpoint is conveniently determined in a spot plate, thus eliminating the need for turbidity compensation and the minimum readable color is approximately 0.1 p.p.m. Any residual between 0.1 and 0.5 p.p.m. can easily be distinguished. In these studies it was found that with a residual of 0.1 p.p.m. (by spot plate test), the bacterial kill effected was from 98.0 to 99.9 per cent.

All of the data reported here were determined by the above technique. This possibly explains the lower results obtained in comparison to those of other investigators.

Chlorine Demand per Capita

There appears to be no data in the literature on this subject and for that reason this phase of the problem was investigated.

In one district serving approximately 34,500 people, it was determined that the flow per capita was 120 gallons per day, and the B.O.D. population equivalent was 34,000. This sewer offered an ideal site for the determination of per capita chlorine demand. The data on this sewer are shown in Table I. The step diagram of these data and the hourly trend curve are plotted in Figure 1. These data and curves also show the method of calculating the hour to hour chlorine demand previously referred to.

From the total chlorine demand and the population tributary, it was calculated that the average domestic demand was 4.666 pounds per day per 1,000 population—0.00466 lbs./capita. A check of these data was made by utilizing, as the population tributary, the B.O.D. population equivalent of two sewers carrying some industrial wastes. The average per capita chlorine demand (24 hours) on these two sewers was calculated to be 0.0052 and 0.0053, respectively. Since these data are preliminary, for convenience the figure of 0.005 pounds per capita has been used but it is believed that the lower figure of 0.00467 is more nearly correct. From other studies it is indicated that the per capita demand in winter is only 65 per cent of the above figure. This phase needs further investigation.

The Chlorine Demand of Sewage

In the field studies, eight sewers were sampled for chlorine demand tests. Each study consisted of sampling at fifteen-minute intervals throughout the twenty-four hours for one to two weeks. The character of the sewers varied from strictly domestic to one carrying a waste almost entirely of an industrial nature. Sewers No. 1 to 4 are tributary to sewer No. 5 and contain the major industrial wastes of the city. Sewer No. 5 is a trunk sewer which also picks up some smaller domestic sewers. It serves 34.3 per cent of the total area of the city (41.1 per cent of the population) and carries approximately 44 per cent of the estimated total city flow. Sewer No. 6 serves 25 per cent of the area of the city (24.5 per cent of the population.) The sewage is primarily domestic and the sewer carries approximately 23 per cent of the estimated total city flow.

These latter two sewers (Nos. 5 and 6) received the greatest attention in the investigations since they carry practically all of the heavy industrial pollution and approximately 66 per cent of the total population. The data collected at different seasons of the year served as a basis for design purposes.

Aside from their use for this purpose, the data collected on the individual sewers assume some importance per se, when it is apparent that with one exception each sewer studied serves a population of over thirty thousand. Table II contains the average dry weather data obtained in the various investigations. As background for considering the importance of the data, the area, population, flow, population equivalent, and temperature of the sewage are included in the table.

Discussion and Comment

From the data in Table II certain observations may be made. These may best be discussed under the following headings:

(1) Variations in Chlorine Demand with Temperature of Sewage

In sewer No. 5 containing packing, tannery and rubber reclaiming plant wastes, it appears that there is little or no temperature effect between 12 deg. and 24 deg. C.; at 8 deg. C. the chlorine demand is about 74 per cent of that at the higher temperature. In sewer No. 6, there is likewise little or no temperature effect between 15 deg. C. and 23 deg. C. This sewer carries some industrial waste (see P. E.), but the chlorine demand is only slightly higher than that of strictly domestic sewage (see sewer No. 7). At a temperature of 10 deg. C., sewer No. 6 has a chlorine demand 65 per cent that at higher temperatures. Both of these figures are higher than those reported by Scott and Van Kleek[9] at Norwalk, Conn. (40%), and by Tiedeman,[13] at Huntington, L. I. (50%). Data collected throughout the year indicate that the higher temperature range may be expected to prevail approximately 65 per cent of the year in Buf-

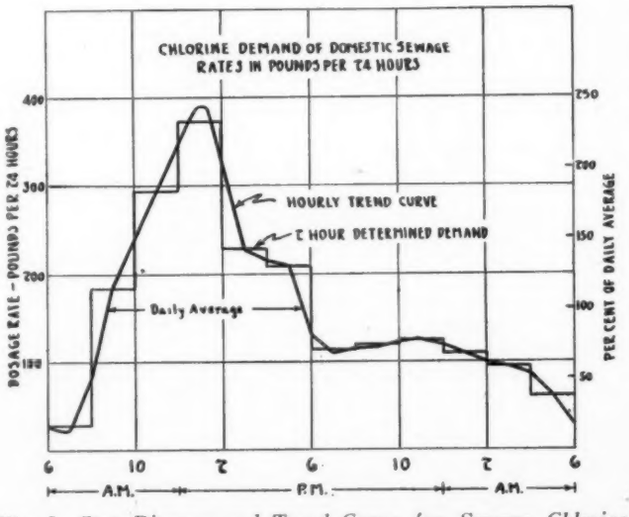

Fig. 1. Step Diagram and Trend Curve for Sewage Chlorine Demand Study.

TABLE II

Summary of D. W. Chlorine Demand Studies at Buffalo, N. Y.

DATE	SEWER NO.	AREA TRIB. ACRES	AREA TRIB. % OF CITY	POP. TRIB. THOUSANDS	POP. TRIB. % OF CITY	FLOW M.G.D.	FLOW % OF CITY (EST.)	TEMP. °C.	B.O.D. POP. EQUIV. 1000	AVG. D.W. CHLOR. DEMAND p.p.m.	AVG. D.W. CHLOR. DEMAND LBS PER DAY	AVG. D.W. CHLOR. DEMAND LBS PER M.G.	AVG. D.W. CHLOR. DEMAND POP. EQUIV. 100	RATIO CHLOR. DEM. TO B.O.D.
JULY-AUG. '36	5 (1)	7515	34.3	740	41.1	47.6	44.1	23.8	397	10.8	4280	90	856	1:15.7
NOV. 1936	5	"	"	"	"	46.2	44.0	17.7	402	10.8	4160	90	832	1:16.4
FEB. 1937	5	"	"	"	"	47.4	41.3	8.4	397	8.0	2820	66.6	564	1:14.
JULY-AUG. '37	5	"	"	"	"	49.4	44.9	24.2	406	8.1 (2)	3340 (2)	67.8 (2)	668	1:10.1
YEARLY AVERAGE (CALC.)										10.0	3730	81.8		
JULY-AUG. '36	6 (1)	5840	25.0	143	24.5	23.4	21.8	22.8	188	5.2	1080	46.2	216	1:19.6
NOV. 1936	6	"	"	"	"	26.1	24.8	14.6	202	5.0	1090	43.5	218	1:31.4
FEB. 1937	6	"	"	"	"	21.4	26.7	9.6	239	3.4	780	28.4	156	1:5.2.
JULY-AUG. '37	6	"	"	"	"	24.3	22.1	21.0	193	5.1	1035	47.5	207	1:31.6
YEARLY AVERAGE (CALC.)										4.8	980	46.0		
AUGUST '36	1	2100	9.8	46	6.9	7.9	7.3	23.3	45.6	4.5	300	38.0	60	1:25.9
JULY 1937	1	"	"	"	"	10.0	9.1	23.0	64.9	4.0	333	33.3	66	1:33.2
AUGUST '36	2	401	2.0	2	0.3	3.9	3.6	25.1	25.1	30.8	1000	256.	200	1:12.8
JULY 1937	2	"	"	"	"	4.7	4.3	26.0	117.0	30.0	1170	250.	234	1:12.0
AUGUST '36	3	1349	6.9	53	9.1	9.9	9.2	23.0	128	13.3	1100	111.	220	1:19.8
AUGUST '37	3	"	"	"	"	9.3	8.4	22.1	105	10.6	840	90.	168	1:21.2
AUGUST '36	4	550	2.6	32	5.5	6.4	5.9	24.6	95.2	25.3	1350	211.	270	1:12.
AUGUST '37	4	"	"	"	"	6.1	5.5	23.8	70.8	14.1	715	117.	143	1:16.9
AUGUST '36	8	858	4.0	34	5.6	3.6	3.3	22.8	340	7.6	230	63.4	46	1:26.6
AUGUST '37	7	1670	7.6	34.5	5.9	4.0	3.6	22.6	34.0	4.8	161	40.3	32.2	1:36.0

(1) SEWER NO. 5 INCLUDES SEWER NOS. 1, 2, 3, 4 AND OTHERS
(2) " " 6 " " " " 7 " "

(2) CHLOR. DEM. OFF 23% DUE TO DECREASED INDUSTRIAL ACTIVITY - SEE SEWER NOS. 3 & 4 FOR 1937.

falo and the lower range the remainder of the year. On this basis, the yearly averages for these two sewers may be calculated as shown in Table II.

(2) Effect of Industrial Wastes on Chlorine Demand

If the difference between the B.O.D. population equivalent and the population tributary is taken as a measure of the industrial load, then it appears that the effect of industrial waste may be quite variable. This becomes obvious by comparing the B.O.D. and C.D. (chlorine demand) population equivalents in Table II.

These data indicate that industrial wastes affecting the B.O.D. may or may not affect the chlorine demand. Some of the wastes greatly increase chlorine demand, others have little or no effect. These observations confirm the experiences at Cleveland reported by Ellms and Pond.[5] In one instance in these investigations the introduction of a waste with a high chlorine demand into a sewer with domestic wastes, definitely reduced the chlorine demand below the calculated summation of the two sewers. (The B.O.D. was similarly affected.)

Attention is called to the August, 1937, results on sewers 5, 4, and 3. The chlorine demand of sewer 5 was approximately 23 per cent or 880 pounds lower than the 1936 results. The combined chlorine demand of sewers 3 and 4 (tributary to 5) was 895 pounds lower than in 1936. Industrial activity on sewers 3 and 4 was considerably less during the 1937 studies than in 1936. However, the B.O.D. of sewer 5 was slightly higher in 1937 than in 1936, indicating that industrial wastes from other sewers were present and affected the B.O.D. but not the chlorine demand.

(3) Analytical Results

On the basis of the population tributary and the population equivalent, sewer 5 may be considered as representing a city of strong industrial wastes. On the same basis, sewer 6 may be considered as representing a city with moderate industrial wastes and sewer 7 represents a small city with no industrial wastes. From this point of view, the data may be compared with those in the literature. Generally speaking, the chlorine demand of Buffalo sewage is somewhat less than that reported elsewhere for similar types of wastes (see Table III.) The ranges, where shown in the table, represent the average seasonal extremes.

The lower results obtained at Buffalo may be attributed in part, at least, to the technique of determining the chlorine demand. The Buffalo data are based on a 15-minute contact period and 0.1 p.p.m. residual chlorine as measured by the Bird Island Laboratory method.[10] However, the B. Coli kill averaged more than 99 per cent in these studies, indicating a high degree of disinfection efficiency.

Two criticisms of the analytical results may be raised by the reader. First, the data presented cover only four short periods at different seasons and may not be representative. Secondly, the results as determined in the laboratory probably are not strictly transferrable to plant operation.

In answer to the first criticism, it may be said that between sampling periods reported in Table II, there were data collected during many sampling periods, and ranging from grab samples to those of 24-hour duration. Analysis of these latter data show that within the temperature ranges cited, there was little variation from day to day in the chlorine demand of a particular sewer. (Sundays, storms, and periods of unusual industrial discharges are of course excepted.) Even grab samples were found to reasonably approximate the chlorine demand for that particular time of day, when compared to the hourly trend curves determined during the regular sampling periods. This conformity of random data (within temperature ranges) to the pattern of the demand indicated by the seasonal sampling periods, strengthens the assumption that the data presented in Table II are representative for the temperature ranges given.

As to the second criticism, it may be said that some of the quoted data in Table III are likewise laboratory results. Actual comparison between laboratory tests and plant scale observation and tests may be determined only by checks against plant operation, when the new plant has been placed in service.

A corollary to this comparison of data is the comparison of the ratio between chlorine demands and B.O.D. values. Bowlus and Banta[4] give a ratio of C.D. to B.O.D. as 1 to 10 for sewage and 1 to 17 for packing house waste. Analysis of figures given by Scott and Van Kleeck[9] show a ratio of 1 to 20 for raw sewage. The summer data presented in Table II average 1 to 30 for Buffalo domestic sewage, with or without some industrial wastes. In cold weather the ratio averaged 1 to 52. For strong sewage containing considerable industrial waste, the summer ratio dropped as low as 1 to 12 and ran up to 1 to 20, depending on the strength of the sewage. On one large sewer with a summer ratio of 1 to 16, the winter ratio was 1 to 24.

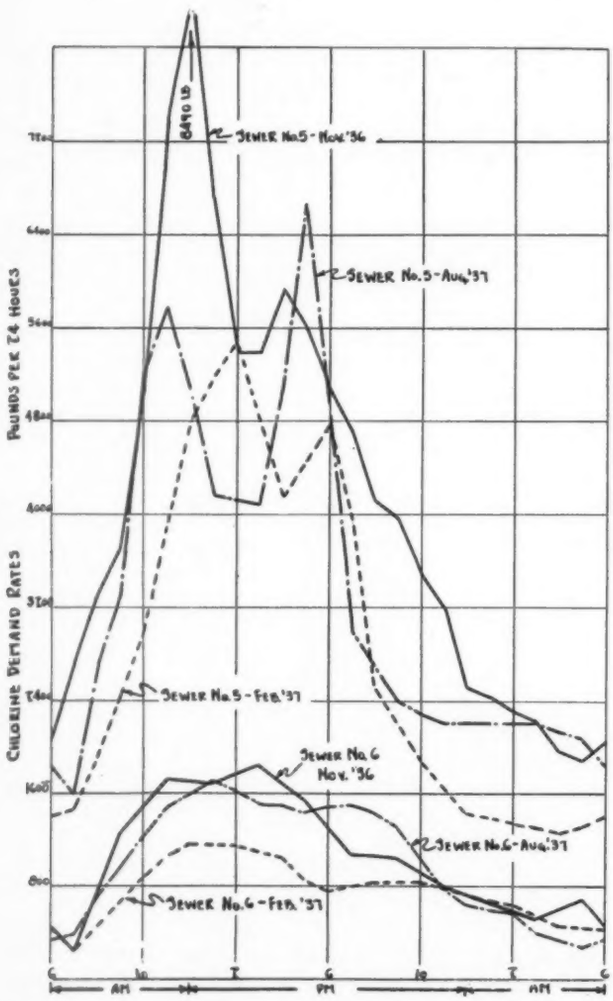

Fig. II. Trend Curves Showing Hourly Variation in Chlorine Demand Rates.

(4) Daily Variations in Chlorine Demand

The data presented in Table II do not show variations from day to day. It may be stated, however, that regardless of temperature, the Sunday demand was found to be on the average 58 per cent of the average for other days of the week, on both of the larger sewers. During the week the maximum demand usually occurred on Tuesdays.

Hourly Variations in Chlorine Demand

In Figure 2 are shown hourly trend curves for three different studies on each of the two larger sewers. These curves are plotted to show demand rates in pounds per 24 hours for the full flows. Four striking observations are apparent from these curves: (1) the effect of difference in quantity and type of sewage in sewers 5 and 6, (2) the effect of temperature, (3) the effect of industrial wastes (see Table II—note 3 on sewer 5—August, 1937), and (4) the wide range and rapid change of chlorine demand, particularly where strong wastes are present.

These curves are based on averages and therefore do not show the greatest observed variations in chlorine demand. They are based on two variables, flow and p.p.m. of chlorine demand. Both flow and demand normally rise and fall together, but appear to bear no definite relation to each other. This point may best be developed by comparing the ranges in both the p.p.m. and the 24-hour demand rates calculated from recorded flows. The data in Table IV show the maxima and minima of each, compared to the average high and low for each sewer during the six investigations. What these data mean in terms of sewage chlorination may better be understood, if it is assumed that the average daily demand shown in Table II is representative of that temperature. With these averages, may be compared the data in Table IV and such comparisons are shown in Table V as per cent of daily average.

The effect of the variation in flow is most evident from the following averages of data in Table V, compared with similar averages for sewage flow.

RANGES OF FLOW AND CHLORINE DEMAND
(Per Cent of the Daily Average)

	Flow Pct.	C. D.— p.p.m. Pct.	C. D.— Lbs./24 Hrs. Pct.
Sewer 5, average high.....	111	186	199
Sewer 5, average low.....	67	54	42
Sewer 6, average high.....	127	144	161
Sewer 6, average low.....	67	36	27

It is obvious from these data that dosage regulation based on flow alone will under or overdose, depending on the time of day. A schedule of adjustment of dosage in p.p.m. appears warranted on the score of efficacy and economy, at least throughout the major portion of the day. The frequency in adjustment has to be determined for the conditions encountered.

Though wide variations may occur in chlorine demand during an individual day, the average ranges show reasonably close trends in per cent of daily average for a particular day or season. Thus it is indicated that seasonal schedules and performance curves may be set up.

TABLE III
Comparison of Analytical Data from Various Sources

CITY	TYPE OF SEWAGE	YEAR	CHLORINE DEM.		PER CENT B. COLI KILL	OBSERVER	
			LBS/MG.	P.P.M.			
BUFFALO							
SEWER No. 5	STRONG INDUST. & DOM.	1936-37	67-96	8-10.8	>99.0	BIRD ISLAND LABORATORY	
" " 6	DOM. & INDUST. MIXT.	"	38+46	3.4+5.6	>99.0	" " "	
" " 7	STRICTLY DOMESTIC	"	40.3(1)	4.8	>99.0	" " "	
BRIDGEPORT, CONN.	STRONG INDUSTRIAL	1917	108	13	99.0	SCOTT & POOL	(8)
CLEVELAND, OHIO	" "	1913-19	71(1)	8.6(1)	96.0	ELLMS & POND	(5)
" "	DOM. & INDUST. MIXT.	"	66(1)	7.9(1)	86.0(1)	" "	
HIGHLAND PARK, N.J.	STRONG INDUST. & DOM.	1935	70	8.4	99.0	RUDOLFS & GEHM	(7)
HILLSDALE, N.Y.	DOMESTIC	1935	53	6.3	99.0	" "	
HUNTINGTON, L.I.		1925-26	54-108	6.5-13	99.0	TIEDEMAN	(13)
MILWAUKEE, WIS.	STRONG	1930	266	32	99.0	MILWAUKEE SEW. COM.	(6)
NEW BRUNSWICK, N.J.	DOMESTIC	1935	58	7.0(2)	99.0(3)	RUDOLFS & GEHM	(7)
NORWALK, CONN.			23-58	2.7-6.9(2)		SCOTT & VAN KLEECK	(9)
PLAINFIELD, N.J.	STRONG INDUST.	1935	87.5	10.5	99.0(4)	RUDOLFS & GEHM	(7)
PORTSMOUTH, OHIO	MIXED	1933	55-108	6.6-13.0	99.8	CRAWFORD	(2)
STOCKTON, CAL.	SCREENED	1919	70-100	8.4-12	90.0	ALLEN	(4)
VIRGINIA BEACH, VA.		1929	83-166	10-20		WATKINS	(14)
WILDWOOD, N.J.	SCREENED	1931	67	8.0	99.0	ALLEN	(4)

(1) SUMMER RESULTS ONLY
(2) ASSUMED VALUE - CHLOR. DEM. REPORTED IS FOR COMPLETE SATISFACTION.
(3) POST CHLORINATION

In this connection it has been observed that the minimum chlorine demand at Buffalo occurs generally about 6 a. m., and the maximum in trunk sewers occurs between 12 noon and 1 p. m. The average chlorine demand on these sewers for any day generally occurs between 9 and 10 a. m., and again between 9 and 10 p. m. [Interesting how this observation checks with those at other points.—ED.]

Referring to Table IV and Table II, it appears that the ranges in p.p.m. found in these experiments differs somewhat from Tiedeman's range[13] of 2 to 10.6 p.p.m. [The case cited is that of a small system and relatively fresh sewage of essentially all domestic origin.—ED.]

Storm Effects on Chlorine Demand in Combined Sewers

Only preliminary data are available on this phase of chlorine demand studies, but these are of interest, because there is a paucity of published information on this phase of chlorination. The data available indicate that the chlorine demand in p.p.m. of combined sewage and storm water is not materially less than that of dry weather domestic sewage and, during the early run-off, is usually higher. With such greatly increased scouring flows the chlorine demand rate per day will increase tremendously if complete demand satisfaction is maintained. The lbs./24 hr. trend curve rises at an astounding rate and then gradually descends.

Fortunately, two factors will operate to prevent excessive dosage requirements in plant operation during storms. First, there is normally only a part of storm flow intercepted or passed through a treatment plant. Secondly, storm water in combination with sewage reduces the concentration of pathogenic organisms. Under this latter condition, only partial satisfaction of the chlorine demand may effect sufficient reduction in bacteria to meet the standard desired in the receiving stream. This will depend upon local conditions and should be subject to investigation where large quantities of chlorine are to be involved, such as in the larger cities.

Up-Sewer Chlorination Studies

There are numerous references in the literature on the subject of chlorination in intercepting sewers. Three primary claims are made for this practice:

(1) Prevents H_2S formation and disintegration of sewers.

(2) Eliminates odors.

(3) Reduces the total chlorine demand below that required by single point chlorination at the treatment plant only.

This phase of sewage chlorination was investigated. The technique of the investigation consisted of collecting sewage from the various sewers (including 1 to 5) that will be intercepted and, thereafter, compositing samples in proportion to respective flows from each. Three tests were made each day, one being made every eight hours, and the studies extended over a three week period in August. The sewage from the contributing sewers was collected at times representing the flow time from one sewer to the next. The additions to the composite tank (40 liters capacity) were made at the same respective times.

Chlorine demand was determined on each sewage sample and the chlorine demand of the composite was calculated. After each addition was made to the tank, the chlorine demand was determined on the mixture. After the last addition, the chlorine demand was determined on the tank mixture at intervals until 5½ hours had elapsed. H_2S was also determined on all samples. The determined chlorine demand was compared to the

TABLE IV

Range in Chlorine Demand of Buffalo Sewage

Sewer	Rate—Pounds/Day: Average High	Maximum	Average Low	Minimum	p.p.m.: Average High	Maximum	Average Low	Minimum
No. 5—November, '36	8,490	11,800	1,890	1,440	20.3	26.4	5.9	4.3
No. 5—February, '37	5,470	17,440	1,260	630	14.5	44.8	4.1	2.0
No. 5—August, '37	6,660	9,620	1,590	1,380	15.4	21.2	4.5	3.7
No. 6—Nov., '36	1,840	2,400	240	190	7.3	9.0	1.6	1.5
No. 6—February, '37	1,170	1,430	240	200	4.6	5.3	1.4	1.4
No. 6—August, '37	1,710	3,410	280	192	7.8	10.5	1.8	1.5

calculated demand. In this series of experiments it was found that, contrary to expectations, the chlorine demand actually decreased 14 per cent in the 5½ hour period.

In another series of experiments, chlorine was dosed in the first sewage added to the tank. This was to simulate conditions if chlorination were practiced on the interceptor. The amount of chlorine added was sufficient for the combined chlorine demands of the various sewages added in the first 35 minutes. A parallel tank, unchlorinated, was also run. At the end of 5½ hours, the chlorine demand of both tanks was determined. The chlorine demand of the first tank, plus the original prechlorination dosage was taken to represent the total chlorine that would be required under this condition of split chlorination. The chlorine demand of the unchlorinated tank was taken to represent chlorine required by the same sewage reaching a single chlorinating station.

In the second series of experiments, comparing the split chlorination with chlorination at the end of the elapsed time, it was found that 25.2 per cent more chlorine would be required by split chlorination than by a single chlorination after 5½ hours. In this series, it was observed that 11.7 per cent of the total chlorine required in split chlorination was lost in the first 35 minutes, before the addition of all of the sewage for which the prechlorination dosage was intended. Therefore, if the prechlorination took place after all of these sewages were added together, this loss could be eliminated. The increase in chlorine demand due to split chlorination would then be 13.5 per cent. This checks the 14 per cent decrease in chlorine demand noted in the first series. There was little or no H_2S present in any of the samples.

The only apparent explanation is that the wastes in sewer 2, which require about 1,000 pounds of chlorine per day and are strongly alkaline, cause some reaction that reduced the chlorine demand when the sewages were mixed. This observation is borne out by field studies and by B.O.D. data on these sewers. The B.O.D. of the mixed sewage was 20 per cent less than the calculated B.O.D. This anomaly was not found in a study of sewers tributary to sewer 6, receiving largely domestic sewage.

On the basis of these experiments, it appears that under present conditions, split chlorination on the Buffalo interceptor and at the treatment plant would entail increased operating expenses and a waste of chlorine.

[It is hardly believed that the Buffalo findings can be duplicated on most systems, wherein the sewage contains sulphates and passes through sewers coated with wall slime teeming with oxygen hungry organisms which break down sulphates, and otherwise raises the chlorine demand, and short time oxygen demand, to embarrass plant operation at numerous points. In addition only partial chlorination is ever justified in up-sewer chlorination practice, complete chlorination proving unnecessary and wasteful. This phase of the Buffalo studies, therefore, lacks practical significance.—Ed.]

TABLE V

Comparison of Chlorine Demand Ranges with the Daily Averages at Buffalo

Sewer	Per Cent of Average Rate: Average High	Maximum	Average Low	Minimum	Per Cent of Average p.p.m.: Average High	Maximum	Average Low	Minimum
No. 5—November, '36	203	283	45	34.5	187	244	54.5	39.8
No. 5—February, '37	194	620	44.8	22.4	181	560	51.2	25.0
No. 5—August, '37	200	288	47.6	41.4	190	267	55.5	45.6
No. 6—November, '36	169	220	22	17.4	144	180	32	30
No. 6—February, '37	150	183	30.8	75.6	135	156	41	38
No. 6—August, '37	165	329	27	18.5	153	206	35.2	29.4

Conclusions

(1) The study of chlorine demand and the results obtained are essentially dependent on local conditions and the strength and type of sewage under investigation.

(2) The results obtained may also depend on the technique of the test. Use of the Bird Island Laboratory method for chlorine demand gives lower results than the standard method and at the same time produces bacterial kills of 98 to 99 per cent.

(3) The chlorine demand per capita for strictly domestic sewage, after many tests, was determined to be 0.00467 to 0.0050 pounds per day, and in chlorine demand expectancy the per capita demand would appear to be a more important figure than p.p.m. demand.

(4) Between 12 and 24 deg. C., temperature of the sewage seems to have little effect on chlorine demand. Below this range the demand was found to be 65 to 74 per cent (depending on type of sewage) of that at the higher temperatures.

(5) Average chlorine demand on relatively fresh domestic sewage is only 4 to 5 p.p.m., and that of strong sewage 8 to 11 p.p.m. Industrial waste and sewage mixtures may have an average chlorine demand of 30 p.p.m.

(6) The chlorine demand during a day may vary from 30 to 560 per cent of the average for the day. The general average range of chlorine demand is from 50 to 190 per cent of the daily average for strong sewage, and 35 to 145 per cent for normal domestic sewage. Close control of chlorine application is indicated where large chlorine installations and sizeable chlorine consumptions are involved.

(7) The ratio of chlorine demand to B.O.D. is entirely dependent on the quality and age of the sewage or the type of industrial wastes present.

(8) Up-sewer chlorination on the interceptor of the sewers did not appear to be indicated as an economical procedure under Buffalo conditions.

Acknowledgment—The authors were assisted in these studies by R. W. Simpson, H. J. Roesser, S. R. Kin, J. E. Januale, J. J. McGuire and C. G. Ketcham.

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THE QUESTION OF CHROMATES IN DRINKING WATER

Of interest to water treatment and public health authorities is the following inquiry and reply to the questions—"How hazardous to public health is the application of salts of chromium to water for the suppression of corrosion of water pipes?"

This inquiry was addressed to the editor of the Journal of the American Medical Association and answered by him in the issue of the Journal of May 7th, 1938, on page 1621. We are reprinting both as a matter of interest and possible value that the opinion of a medical authority may have to the water works profession and health officials.

To the Editor—Recently one of our county health commissioners directed attention to a proprietary preparation which was being added to the water supply of a school for the purpose of preventing corrosion of piping. Examination of the product indicated that it was a solution of sodium silicate and a chromate. The laboratories reported the specific gravity to be 1.41, total solids 63.6 gm. per hundred cubic centimeters, silica SiO_2 29% by weight, chromium in terms of sodium chromate, Na_2CrO_4, 0.44% by weight. The distributors of this product state that their prescribed dosage is 1 quart to 5,000 gallons of water. This is equivalent to 0.31 part per million of sodium chromate, Na_2CrO_4, or to 0.10 part per million of chromium. It is understood that it is added either to the cold water supply or to the hot water supply or to both. Information at hand indicates that several schools and certain commercial interests have been using the product and that its use may tend to extend. I have been unable to locate any reference as to the effect of drinking water containing small amounts of chromium and would greatly appreciate your opinion as to whether you would consider either the intermittent or the continued drinking of water containing chromium to the extent of 0.3 part per million of sodium chromate might have any harmful physiologic effect, and what limit should be set for the chromium content of drinking water.—Walter H. Hartung, M. D., Columbus, Ohio.

Answer—Chromate as here applied represents hexavalent chromium, but in the presence of water with any appreciable organic content and after a considerable interval of time, represented by hours, this hexavalent chromium may be changed over to a trivalent compound. Trivalent chromium is substantially nontoxic, but the hexavalent compounds are much more toxic. The presence of excess chlorine in a water supply tends to inhibit the chemical change mentioned. Moreover, since the query refers to a school water supply the implication is that the elapse time between chromium water treatment and water use might be much less than is true for a large city. In the case of inhaled chromates, the upper limit of safety for extended exposures is somewhat arbitrarily fixed at 1 m.g. of chromates to 10 cubic meters of air, the latter figure approximately the quantity of air breathed by an adult during a work day. Under the circumstances mentioned it appears that if a gallon of water should be consumed daily, approximately 1 m.g. of the chromate would be ingested. Probably this quantity would lead to no demonstrable physiologic abnormalities, but an unequivocal stand may not be taken.

At this time, compounds containing chromium are regarded as sensitizing agents. It is conceivable that chromium in small quantities might lead to dyfunction because of sensitization. It is more likely under other circumstances that workers sensitized through greater exposure connected with employment might respond through allergic manifestations to the minute traces mentioned, following ingestion, or even in connection with bathing. It is the intent of this discussion not to condemn the practice mentioned in the query as wholly unwarranted but to point out the possibility of ill effects.

▼

Joint Meeting of N. E. and N. Y. Sewage Works Ass'ns Promises to Be the Biggest Ever

On October 6, 7, and 8, 1938, will be staged a highly important meeting of sewage works men. The New England and New York Sewage Works Associations are to hold their second joint meeting at the Hotel Bond, Hartford, Conn. Preliminary plans call for a program and manufacturer's exhibit that will probably excel that of the highly successful joint meeting of these two associations held three years ago in Schenectady, N. Y.

In the technical sessions results of important experiments in sewage oxidation, conducted by the U. S. Public Health Service, will be presented. Discussion will also be devoted to current methods of sludge dewatering; qualifications of sewage works operators; public relations and public service in sewage disposal; mechanical operation in sewage treatment.

After the "Sunrise Breakfast" and the "Question Box" on Saturday morning, the new treatment plant of Hartford will be visited. Thereafter, the Guggenheim Plant at New Britain will be inspected.

From Secretaries Bedell and Gilcreas, of the two associations comes word that manufacturers' exhibit space has been sold out, and that all indications point to the Hartford meeting being the most impressive sewage works meeting that has ever been held in this country. For this special meeting particular attention is being given features of entertainment, those attending being urged to bring along their ladies.

IRON PICKLING WASTES IN SEWAGE

Cause and Effect

By CHARLES F. HAUCK

Junior Chemist
Southerly Sewage Treatment Works
Cleveland, Ohio

SOME years ago large quantities of wastes from steel plant pickling vats caused trouble with the trickling filters at the Cleveland Southerly Sewage Plant. At that time a careful and complete survey of the main sewer interceptors contributing sewage to this plant was made by G. E. Flower, Supt. of the plant. The source of pollution was found to be a large wire mill. The mill was ordered to cease discharging the offending wastes into the city's sewers. The total iron content of the sewage diminished immediately and the trickling filter difficulties disappeared.

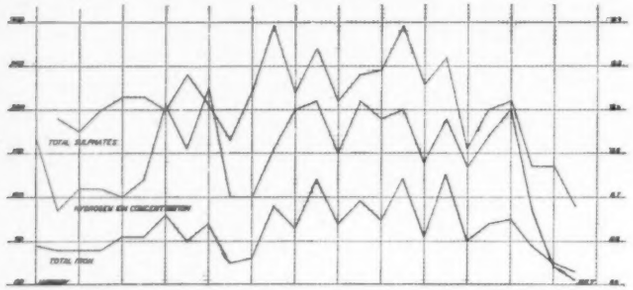

Fig. 1—P.P.M. Iron (Fe), Sulphate So_4 and pH Values of Cleveland Southerly Sludge, During Steel Mill Operation, January to July, 1937.

Early last year (1937) large amounts of iron reappeared in the sewage but without any attendant operating complications, as only the Imhoff tanks were being used, without the trickling filters and final settling tanks. With the increased iron, we also noted in the laboratory the peculiar behavior of the chloride test, increasing quantities of solids and sulphates, and decreasing pH values. We also began to find ferric hydroxide precipitates in the B. O. D. bottles and interference with this bio-chemical test.

To the operator, one interesting aspect of our experience was the assistance laboratory data could be in forecasting plant problems. Catch samples on two occasions showed that the sewage had been completely sterilized by the germicidal action of the acidic iron wastes, as there was neither gas in 0.00001 cc. after 48 hours incubation at 37° C., nor any colonies on solid agar media after 24 hours' incubation at 37° C. These catch samples carried as much as 1500 ppm. of iron of which 1300 ppm. was in the ferrous form. With a pH of 5.7 they contained as much as 2500 ppm. of sulphate (SO_4), and an acidity of 530 ppm. expressed as sulphuric acid. Any plant making use of the activated sludge process would be completely upset by the introduction of such wastes into the plant flow, and experience has taught this to be so. The evidence gathered from analysis of catch samples convinces one that these pickle vat discharges travel like a slug through the sewers into the plant, without being much diluted or mixed with the flow of normal sewage preceding and following these discharges.

To both the operator and the chemist it is significant that there exists a striking correlation, as shown here graphically, between the sulphate and iron contents. The coincidence of a steel strike, with the sharp reduction in iron and sulphates and rising pH value [together with the later upturn (data not shown), in these curves upon the reopening of the plants] led us to suspect them of being responsible for the wastes in the sewage.

Effects on the Chloride Test

Especially to chemists in those plants where the determinations of chlorides is routine, our observations will be helpful. Although Standards Methods of Analysis does not mention ferrous iron as an interfering ion in the argentometric titration of chlorides using potassium chromate as an indicator, it caused us considerable difficulty. Invariably, when the sample contained much iron a heavy reddish brown precipitate of ferrous chromate formed. This precipitate, which much resembles silver chromate, made it impossible to detect the end point.

The problem of correcting this interference was met in two ways. 1. To a 50ml. sample, one ml. of hydrogen peroxide was added and warmed for about 5 minutes. The sample was cooled and filtered. Two ml. of potassium chromate was then added and the sample titrated in the usual manner. Losses in the volume of sample due to evaporation and absorption by the filter paper can for ordinary purposes be ignored.

2. To a 50ml. sample, 2 to 3 ml. of potassium chromate were added. The sample was then filtered through fine filter paper and then titrated in the usual manner. Because the chromate ion is precipitated and removed, it is sometimes necessary to add more indicator to give the desired color intensity for the chloride test.

It is, therefore, evident that industrial wastes containing acid and ferrous iron may seriously interfere with plant performance, if in sufficient amounts. Their presence may be indicated by laboratory analyses which when properly correlated and graphically shown will give a clue to the source and origin of such wastes.

The help and assistance given me by Mr. J. W. Ellms, Sanitary Engineer, Dept. of Public Utilities, and Mr. G. E. Flower, Supt. of Southerly Sewage Treatment Plant are gratefully acknowledged.

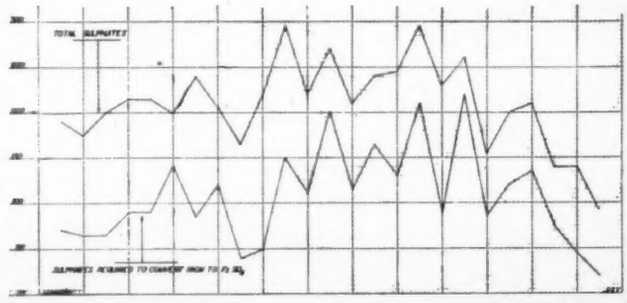

Fig. 2—Difference Between Total Sulphates and Sulphate of Iron, Indicating Sulphates Contributed as Sulphuric Acid to Southerly Plant Sewage, January to July, 1937.

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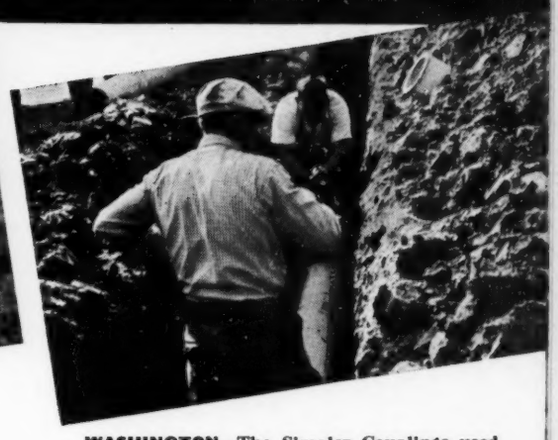

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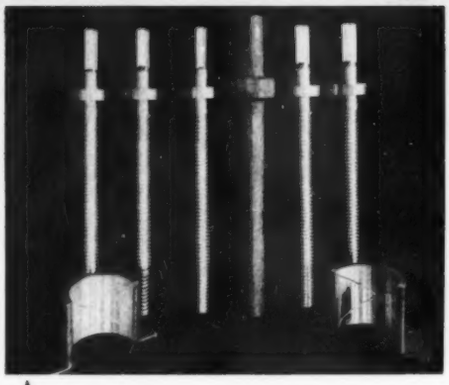

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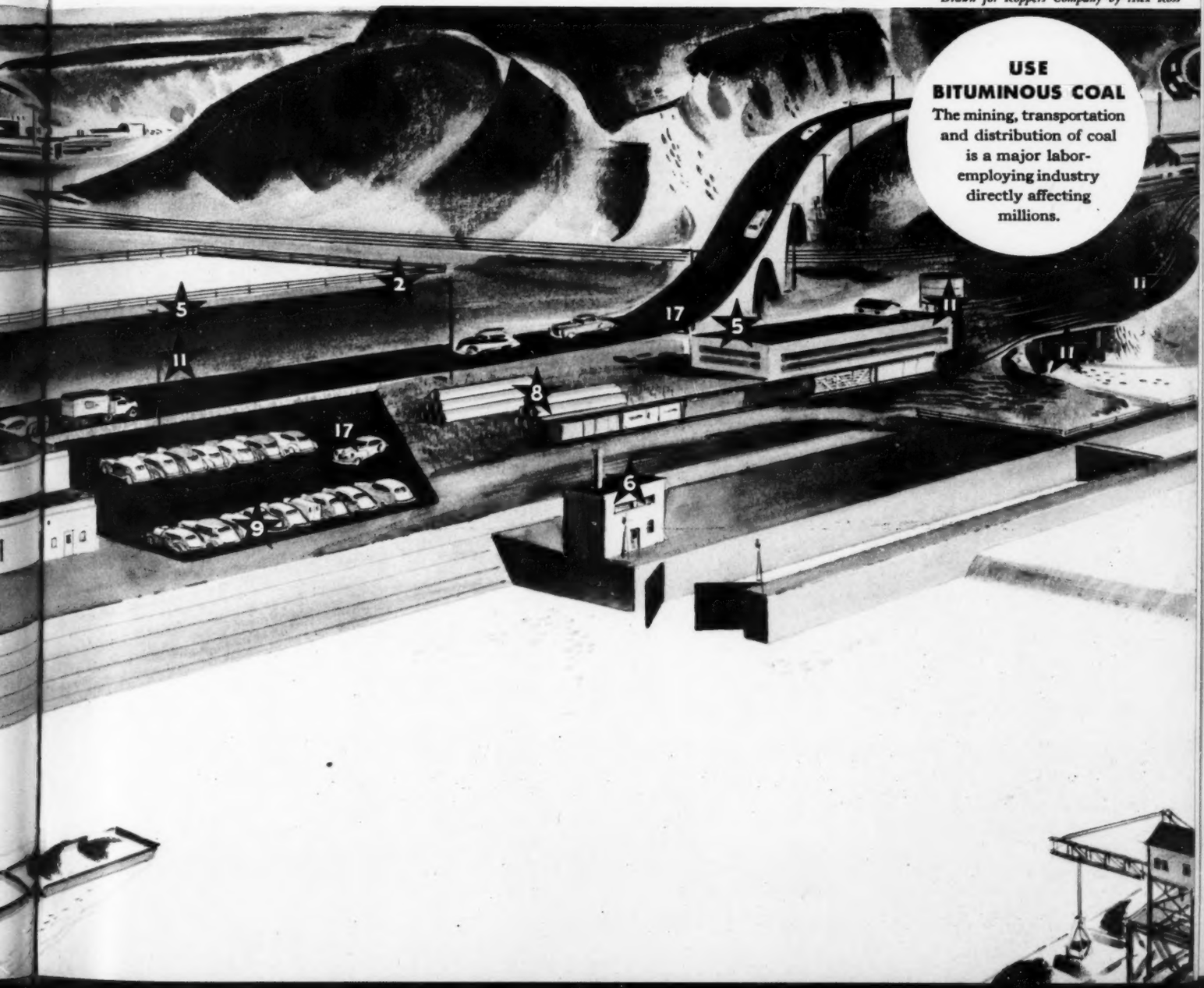

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DISAPPROVED PLUMBING FIXTURES

How Hazardous?

By ARTHUR B. CRONKRIGHT*

New York City

The Author

THE question "How dangerous are defective plumbing fixtures?" has been raised as a result of the publication of the results of the plumbing survey of federal buildings in New York City and Detroit which was jointly sponsored by the U. S. Public Health Service and the Works Progress Administration. The summary report[1] of this survey stated that 75% of the plumbing fixtures inspected in the Detroit buildings and 67½% of those inspected in the New York buildings were classed as "disapproved fixtures." The report also defined "disapproved fixtures" to mean those which contained any possibility of permitting the contamination or infection of the water supply. Neither the frequency nor infrequency of occurrence of this possibility was considered. Since the frequency of occurrence is probably the most important consideration in the determination of hazards represented by defective plumbing fixtures and installations, it deserves considerable attention.

Influencing Factors

In analyzing the factors influencing the conversion of a plumbing fixture or installation into a medium for the spread and transmission of disease organisms, the possibility of the occurrence of several conditions must be considered:

1. In most cases it is first, necessary for a vacuum to occur in the distribution system or the supply line to the fixture in order that back-flow of contaminating material may take place.

2. The control valve or inlet to the plumbing fixture must be open, leaking or in a poor condition; or it must be of such design that it will allow the passage of liquid or other material back through it under the influence of a reversal of pressure.

3. The inlet to the fixture must be submerged or have the possibility of being submerged; or it must be in contact with or in close proximity to contaminating material.

4. Finally, the material that is siphoned, forced, or drawn back into the water supply must be of a contaminating nature and detrimental to health.

Bearing in mind the four factors outlined above, it is now possible to examine the various plumbing fixtures and appliances and arrive at some conclusions as to the amount of hazard represented by the installation and use of each. The number of different plumbing fixtures and applications is almost endless. An examination of only the most common fixtures will be made. The conclusion drawn from these most common fixtures will be found applicable to a large extent to most of the plumbing appliances and installations not considered here.

The Water Closet

One of the most common and probably one of the most important plumbing fixtures in use today from a health standpoint is the water closet. The development of this device for the disposal of waste has coincided with the development of a modern civilization. Applying the four factors necessary for the spread of contamination and possibly disease through plumbing fixtures supplying water to the water closet, the following circumstances are involved:

1. A back flow must take place in the supply line to the fixture and for this to happen, a vacuum is essential in that supply line. The frequency with which this condition occurs will be described later.

2. The necessity for the control valve to permit the passage of waste or contaminating liquid or material. The inherent characteristics of most flushometer valves on water closets is that they will open by themselves when subjected to a reversal of pressure. A few valves of this type may tend to seat tighter under the application of a vacuum in the supply pipe. It has been demonstrated, however, that even valves of the latter type will, under certain conditions, open for the time necessary for contaminating or waste material to enter the supply line. In any case, the valve may be in poor working condition and may be leaking.

As for the types of valves found in high and low tank water closets, they may or may not permit the back flow of the tank contents. The leaking, sticking open or general ineffectiveness of the ball-cock valve used in these tanks is well known. Most everyone has had the experience of encountering a leaking tank toilet. If the rubber stop in the outlet of the tank fails to seat properly, water continuously leaks out and the float in the tank is kept at a level that will allow the supply valve to be open and supply as much water to the tank as is wasted from it. Should a vacuum occur and cause water to be siphoned into the supply pipe, the float would drop and cause the valve to be opened further, facilitating the back-flow of the tank contents.

3. As for the condition that the inlet to the fixture be submerged, it may be stated that in all cases except a plain flushometer-supplied-flush-rim toilet, the inlet to the fixture *is* submerged. Stoppage in a flush-run closet and consequent submerging of the flush-rim ports is not so infrequent that the possibility may be ignored.

4. The condition that the contents of the fixture which may be drawn or forced back into the supply line must be of a contaminating nature and deleterious to health. As for a flushometer supplied water closet, no one will question the statement that the contents of the closet itself, in other words the trap seal, are to be considered as unsafe for human consumption. The ques-

*Project Supervisor, U. S. Public Health Service, District No. 1.

[1] Public Health Hazards in Plumbing. U. S. Public Health Service, Washington, D. C., December, 1937, 37 pages.

tion as to whether or not the contents of a water closet tank are of a safe quality is debatable. Investigators into the prevalence of plumbing defects have reported the finding of dead animals, vermin, decomposing vegetable matter, cigarettes and sometimes articles of personal hygiene in the tanks inspected. These conditions have thus far been considered as the exception rather than the rule. In the course of the completion of the plumbing survey of the federal buildings in New York City, the opportunity presented itself for determining the relative quality of the water found in water closet tanks. As a result, a series of 211 tests were run on twenty overhead open-top tanks in a municipal comfort station to determine the bacteriological quality of the water, as indicated by the presence or absence of the coli-aerogenes group of bacteria. The results of these tests showed that the average result for 19 out of 20 tanks investigated indicated water of a quality below the standards set for domestic purposes. The remaining tank, while having an average bacterial count within the limits set for drinking water, did show in several instances water of an unacceptable quality.

Summarizing the above facts, the conclusion is reached that as far as water closets are concerned, the frequency with which a vacuum will occur in the supply line to the fixture will in most cases determine the frequency with which the fixture will become a health hazard. That the other factors necessary for the spread of contamination and possibly disease organisms are present, at least in the majority of instances, has been shown.

Other Bathroom Fixtures

Leaving the subject of water closets for the time being, consideration may now be given of the other plumbing fixtures that are commonly encountered. Foremost among these are the lavatory, sink and bathtub. There is a similarity in the construction and use of these three types of fixtures that permits the analyzing, simultaneously, of the factors influencing their becoming health hazards.

Applying the four criteria to these fixtures, it is found that:

1. Except for the bottom supplied type of lavatories, sinks and bathtubs, the foremost necessity for the spread of contamination through these fixtures is the occurrence of a vacuum in the supply line to the fixture. As with the water closet, this possibility will be discussed later.

2. The control valve to any of these three types of fixtures must be open, leaking or of a design or in a condition such as to permit the back-flow of contaminating material through it. The frequency with which such a condition exists is again debatable. However, again referring to the results obtained in the plumbing survey of the federal buildings in New York City, we find that out of 9,218 common lavatories, sinks and bathtubs inspected, the number of leaking faucets or taps reported were not very numerous. The possibility of the supply line valve to these fixtures leaking is not very serious. This valve, however, must be open during the use of the fixture. The per cent of the time that a fixture of this type is in use and the valve open deserves further investigation, as it regulates one of the factors influencing the hazard represented by the installation and use of the fixture. It is well to remember, however, that fixtures of this type are used to rinse and wash various articles and the valve is often open for an extended period.

3. Consideration is given next as to whether or not the inlet to the fixture is submerged or in close proximity with the fixture contents. As for bottom supplied types of lavatories, sinks, or bathtubs it may be said that the inlet is continuously submerged when the fixture is in use.

As for the fixtures of the type that are supplied from over the top or from the side at a point above the overflow of the fixture, there are several other factors that must be considered in determining the hazard presented. The inlet to the fixture must be below a point approximately twice the inside diameter of the inlet above the flow line to constitute a hazard. The overflow in many instances must become stopped up or it must be of such design that it is unable to discharge the contents of the fixture as quickly as the fixture is filling. The frequency with which these conditions occur is unknown but is suspected to be relatively small. Experience with fixtures of this sort does not record many instances of the occurrences of such coincidences.

4. As to the condition that the contents of the fixture be of a contaminating nature or deleterious to health, it is safe to say that under very few conditions could the contents of these fixtures be considered as not being of a dangerous character when regarded as a source of water for drinking purposes.

Therefore, the hazard in the fixtures considered above, namely, the lavatory, sink and bathtub is dependent, first, upon the occurrence of a vacuum in the supply line, second, that the control valve be open or leaking; and, third, that the fixture be in use with the inlet submerged or less than a distance of approximately twice the inside diameter of the inlet above the water surface.

In comparison with the water closet, it will be noticed that the hazard presented by the last three types of fixtures is considerably less, as indicated by the fact that the factors necessary for contamination of the water supply to take place through the fixture are not as consistently present.

How Frequent the Necessary Vacuum?

Thus far, no consideration has been given to the frequency with which a vacuum will occur in a distribution system or the supply line to a fixture. Heretofore, in determining whether a fixture is to be considered as a menace to the water supply quality, a vacuum has always been assumed to occur. Since the frequency of vacuum occurrence is the prime factor in determining the hazard presented by water closets and to a lesser extent by lavatories, sinks and bathtubs, it is essential that information be obtained as to how frequently a vacuum will occur. This fact was realized during the course of the plumbing inspection survey of federal buildings in New York City and subsequent to the completion of the survey, a study of the vacuum frequencies in six New York office buildings was undertaken. This consisted of installing a pressure recording gauge in each of the buildings studied at a pre-determined point in the distribution system. The point selected was one at which a vacuum would be most likely to occur. Records of the water pressure were obtained at this point until the frequency of vacuum occurrence was observed or could be estimated. The reresults secured from this study may not be entirely accurate insofar as determining how frequently a vacuum will occur in any one building, yet they serve as a means of comparing the various buildings studied. For example, as a result of the vacuum study in Building "B," the second office building to be investigated, it was found that a vacuum was observed to exist on the fifth or top floor of that building slightly over twenty-four per cent of the time. Stated simply, this means that vacuum, not necessarily continuous, occurred in the building for almost six hours out of every twenty-four. Had any supply line valve to a water closet leaked or been opened during this

time, contamination of the water supply *might* have taken place. Fortunately, these vacuum conditions existed at night when the building was unoccupied and the fixtures were not in use. Also, the water closets on that floor were all of the open top overhead tank type, which are not as likely to back-siphon as are flush valve toilets.

In comparison to the conditions existent in Building "B," the results obtained in Building "A" indicated a vacuum frequency of only 37 *ten-thousandths* (0.0037) of one per cent. This may be taken to mean that vacuum will occur in Building "B," 24½ divided by 37 ten thousandths or approximately 6,600 times as often as in Building "A." In other words, disapproved fixtures in Building "B," will be potentially 6,600 times as hazardous as the corresponding fixtures in Building "A."

Every Building on Its Own

The result of this comparison is a better appreciation of the dangers exhibited by the defective fixtures in Building "B." While Building "A" may appear relatively safe by comparison, the results of the vacuum study show two other buildings with a lower vacuum frequency. In fact, the frequency for Building "C" was so small as to be almost insignificant.

This discussion of the hazards represented by the various plumbing fixtures is not complete and is intended primarily to illustrate the various factors influencing the contamination of the water supply through this means and to show the need for a further investigation into the frequency of occurrence of these various factors. It is suggested, in the event of any further investigations of either the prevalence of or the hazards presented by defective plumbing fixtures, that due consideration be paid to the frequency of occurrence of these various factors and study be given to devising means whereby the "hazard factor" of each fixture may be determined and recorded.

Acknowledgment—This paper read before the N. Y. State Association of Master Plumbers, has been submitted for publication in WATER WORKS AND SEWERAGE.

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TREATMENT TRAILER BECOMES "VAGON DE TRATAMIENTO"

From Jeff Corydon in Mexico City came the above photograph of PROPORTIONEERS Treatment Tailer which, following the A.W.W.A. convention in New Orleans, was presented by Louisianans with a new accoutrement in the form of a "little green box" planted with mint from the famed Albania Plantations of Jeanerette.

And—Grows a Beard of Mint

Jeff says the theme song of "EL VAGON DE TRATAMIENTO" in its extended tour of Mexican municipalities. since New Orleans, has been "Minting While You Ride." And, neither the end-product (nor Mexico) has been "hard to take."

BILL WEIR REWARDED FOR SERVICE TO S. E. SECTION

W. H. Weir, of Atlanta, Ga., recently resigned as Sec'y-Treas. of the Southeastern Section of the American Water Works Association, completing eight years of service to the Section as its secretary, and three years as its member on the National Board of Direction of A.W.W.A.

H. F. Wiedeman Presents the Pitcher to Weir

The energy and enthusiasm which Mr. Weir put into his job, when he took hold, more than doubled the membership of the Section within a few years, to win for it the Hill Cup given for the greatest percentage increase in membership amongst the several sections of A.W.W.A.

Mr. Weir, as engineer in charge of water supply and sewerage work for the Georgia Department of Health, has done a laudable job in promoting better design and operation of water and sewage treatment plants in Georgia. And, was instrumental in organizing the very successful Georgia Water and Sewage Operators School from which voluntary operator licensing has been an outgrowth.

In recognition of, and reward for, the valued services rendered the Southeastern Section an appropriately engraved silver pitcher and a pair of goblets were recently presented to him. In the picture above, H. F. Wiedeman, Atlanta consulting engineer (former Section Chairman and, later, A.W.W.A. Director) is presenting Mr. Weir (right) with the memento of appreciation and esteem of those he served so well.

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2nd California Short School Held at University of California

Under the auspices of the California Section of A.W.W.A. and the California Sewage Works Association, the 2nd Short School for Water and Sewage Works Operators was held at the University of California June 22-24 inclusive.

The school, with a registered attendance of 34 operators (15 being in charge of sewage treatment plants and 19 in charge of water purification plants) was considered a highly successful second short school. The courses of instruction and the arrangements were planned by a joint committee, representing both associations, and headed by Harold F. Gray of Oakland.

The Editor's Comments

"HOW HAZARDOUS IS HAZARDOUS?"

ACTUALLY, how hazardous are so-designated "disapproved plumbing fixtures"? This question is asked, discussed and in part, answered in the article "Disapproved Plumbing Fixtures," by Arthur B. Cronkright of the U. S. Public Health Service, which appears in this issue. There is no possibility of a full answer to the question "How hazardous are hazardous plumbing fixtures?" That is, there is no more possibility of answering it than there is of answering the question "How often will a turkey cross the road before it becomes turkey-hash under an automobile wheel?" Both questions bring to mind the status of the "sanitary survey," the importance of which is drilled into the young sanitarian upon his first connection with a public health unit. "How dangerous is this or that water supply, when bacteriological analyses fail to indicate pollution?" is the familiar question which only the sanitary survey of source of supply and methods of handling of the water can indicate. We say *indicate* purposely, because although the sanitary survey may reveal potential hazards it can, taken alone, never prove beyond doubt that the supply has ever been, or will ever become, actually dangerous.

One of the chief topics of discussion at meetings of water works men, sanitarians and plumbers, during the past several years, since the outbreak of amoebic dysentery in Chicago, has been that of the hazards of hidden cross connections within buildings, and what may happen in the way of back-syphonage from toilets and other plumbing fixtures. There has been much investigation of plumbing fixtures and definitions as to what constitutes safe and unsafe (disapproved) fixtures. There have been numerous surveys of many buildings, and reports filed on the alarming prevalence of disapproved fixtures thus located. Out of all this has been created jobs and work for sanitary engineers, but more work and profit for plumbing fixture supply houses and plumbers. The scare created was sufficient to cause the water works man to dream at night of what dire things might be happening over his system to contaminate the mains through back-syphoning of disapproved fixtures. We have been one to believe the "hullabaloo" more than seemed justified.

On more than one occasion the question has been raised, "Well, if this recently discovered fixture hazard is as dangerous as it is pictured to be, why aren't the most of us long since dead?" In other words, the question raised was in reality this: "Admitting that danger potentially exists, what is the true 'hazard-factor'?" This is the question which we have not seen reported upon until the U. S. Public Health Service undertook to answer it. Possibly the question, "Why aren't we all long since dead?" is answered in the results of the survey of those Federal buildings previously reported by the U. S. Public Health to have an uncomforting number of "disapproved" plumbing fixtures. It is something of a relief now to learn from the findings, as revealed in Mr. Cronkright's report and discussion in this issue, that in the face of what-might-have-been in only one out of the four buildings surveyed, could the "disapproved" fixtures be considered as more than remotely dangerous. The whole answer hinges on the frequency and extent to which a negative pressure occurs on deficient interior piping system. In one building a vacuum was observed on the upper-most floors, but there was no evidence of back-syphonage through the disapproved fixtures. In another building a negative pressure was recorded less than four one-thousandths (0.0037) of 1 per cent of the time. In the other two the occurrence of negative pressure was classed as "negligible," if any. For the tests, the point selected was that at which a vacuum was most likely to occur.

It must be concluded, from this survey, that it is necessary to go beyond condemnation of fixtures classed as "disapproved" and to consider the "hazard factor" of every individual fixture. Perhaps there is more to be said concerning "disapproved" interior piping, in respect to size and condition, which when corrected would drop the "hazard factor" of most fixtures to absolute zero. "Disapproved interior piping" is the real thing to go after, not alone as a public health measure, but in order that the service rendered by the local water utility may be less scientifically criticized.

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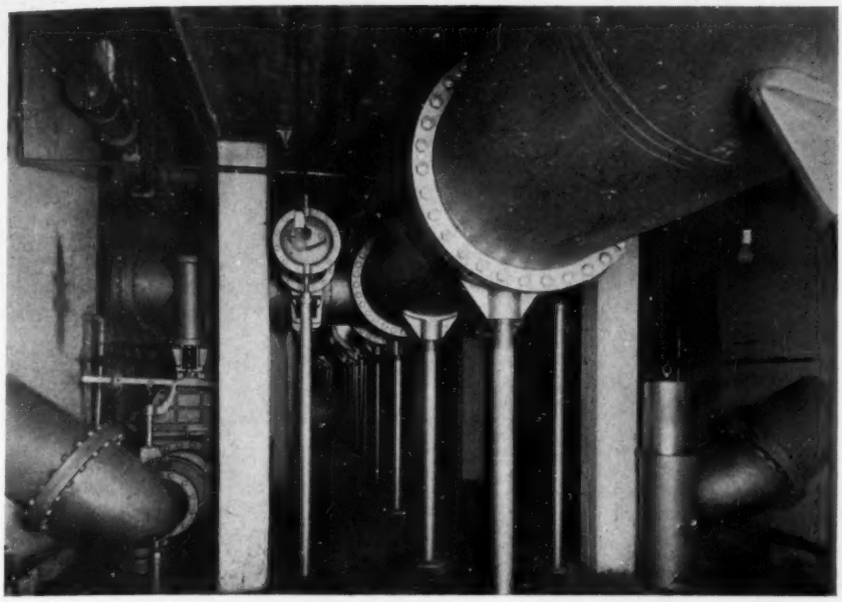
WHEREIN THE HOLE IS WORTH MORE THAN THE DOUGHNUT

IN setting forth "Experiences with Water Main Cleaning," Thos. B. Ray presents in the featured article of this issue, a new concept to the worth of water-main cleaning, which seems fundamentally sound. Mr. Ray goes beyond the usually accredited benefits from main-cleaning, such as increased capacity, better pressure, lower pumping costs, better insurance ratings. He also claims increased value of the system is the result. Mr. Ray reasons that cast-iron pipe, in service, depreciate with age only on one score, namely in its loss of effective internal diameter due to tuberculation or scale deposition. He argues, then, that a cleaned main is for all intents and purposes a new main, and should be revalued as such on the books. That is an interesting light, and naturally of greatest interest to water companies passing through or faced with the valuation proceedings. It is of little consequence that there are actually less tons of cast-iron in the system after each successive cleaning than there was before. Fundamentally, so long as the pipe holds the pressure without leaking it is just as valuable for the purpose it serves as when it was new, even though it weighed more when installed. In other words, Mr. Ray hits the nail on the head when he considers that pipes are in reality bought on the basis of their water-way capacity, even if paid for on the basis of tonnage of material involved, and valued on the basis of the effective diameter of the "hole" through the earth. Here then is a case wherein the hole is worth more than the doughnut.

Mr. Ray's article is being featured because we believe there are by far too many systems in America which are in the same, or worse, condition than those rejuvenated by his cleaning program. Also, there are many that have cost their owners surprising sums in power bills, if the high cost of friction were capitalized. There are certainly many which have choked small-diameter pipe-lines, serving out-lying consumers none too well, which may be rejuvenated by the simple acid cleaning process as successfully and economically as were those under Mr. Ray's jurisdiction. The question that water works managers should answer is *not*, "Can we afford to clean our mains?"—it should be "Can we afford *not* to clean?" Why main cleaning has not sold itself more prevalently is a mystery that power companies and fire underwriters will never understand.

SIMPLEX RATE CONTROLLERS



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Pipe Gallery, Denver, Colorado, Filter Plant

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The large, clean, pipe gallery of Denver's new filtration plant is but one of the many plant features which have aroused favorable comments from designing and operating engineers.

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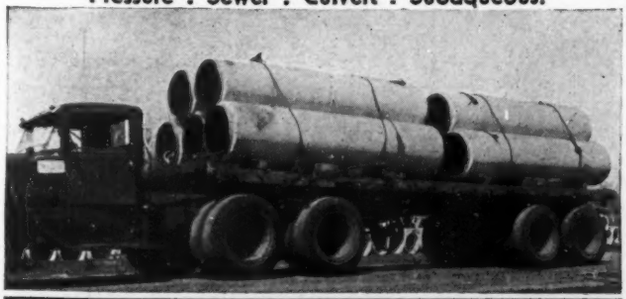

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1. Clean the flange.

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TAPAX is the surest relief from rattling, banging manhole covers and offers you the simplest solution for noisy covers at a cost of comparatively a few cents an application. TAPAX is a resilient cushioned composition of asbestos and bronze, shipped in convenient reels. It will "stay put" for years. Ask for sample.

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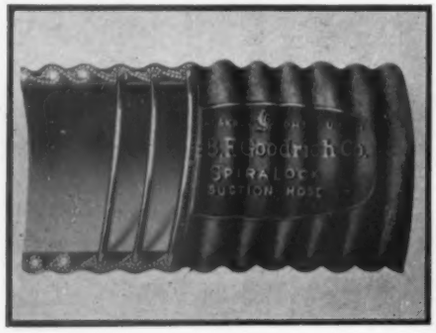
EQUIPMENT NEWS

"Spiralock" Hose for Suction or Pressure

A reinforced hose, introducing an entirely new construction, has been announced by The B. F. Goodrich Company, Akron, Ohio. Known as "Spiralock," this smooth bore hose is designed for either suction or discharge service and is capable of handling pressures up to 30 lbs. per square inch.



New Hose by Goodrich

The new hose derives its name from the patented Spiralock construction. Developed by Goodrich engineers, this special construction makes possible a hose which is light in weight and extremely flexible for easy handling, yet sufficiently durable to withstand hard service. Locking of the fabric around the spiral wire insert, anchors the wire securely in place. Should the hose be crushed, the wire can be pounded back into position without serious damage.

Spiralock Suction Hose is available in sizes ranging from 1½ to 4 inches and at present is limited to 20-ft. lengths, with straight or enlarged ends. Where special couplings are to be accommodated, the O. D. of ends can be varied by minus ⅛ to plus ¼ inch, and the length of blank ends may also be altered. For further details write B. F. Goodrich, Mechanical Rubber Div., Akron, Ohio.

▼

Permutit Rate-of-Flow Indicator

The Permutit Company, New York City, announce a new Rate-of-Flow Indicator of unique design. The brass body of the indicator contains two air chambers which also serve as drainable sediment traps. Into the bottom of each chamber connect the small copper tube lead-lines from high and low pressure sides of the orifice plate or venturi tube in the flow line. From the top of the air chambers a small passage transmits the differential air pressure to a pair of phosphor-bronze bellows with a connecting link between. Through a magnifying linkage (see cut) the pointer moves over the calibrated scale, with changes of flow.

An interesting feature of the new Permutit Indicator is that it operates equally accurately on reverse flow, without manipulation of valves on the lead lines or indicator. For instance, in back washing a filter or zeolite softener through a common pipe line, the wash rate is indicated by swing of the pointer to the left of the zero flow line; and, to the right when filtering or softening. The indicator is simple, inexpensive, compact (3½x5⅞x5½), and is ruggedly constructed for pressures up to 100 lbs. sq. in. And, no damage can be done if the full line pressure is admitted to either bellows chamber with the other shut off. It may be set in an instrument panel, attached to a wall, or supported directly on the flow line by the two short pressure lead lines.

For further information, request the new bulletin "Rate of Flow Indicator" from The Permutit Co., 330 West 42nd Street, New York City.

Indicator-Cover Removed

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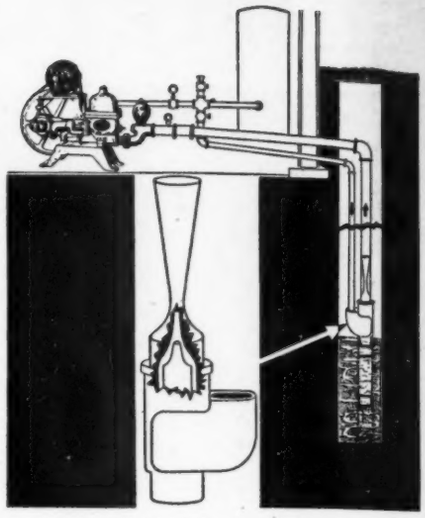
An Idea in Lift Boosting

Recently, this unique scheme and equipment has come to our attention in *Johnson's National Driller's Journal.* It seems worthy of passing along.

The device is an ejector or eductor (which is right?) that "steals" from a pump discharge enough high pressure water to boost the water level in the suction pipe to a point where an ordinary pump is capable of taking it the balance of the way. It is claimed that an ordinary well pump or centrifugal can, with this boosting ejector, take its full capacity of water from depths down to 80 feet.

This reminds us of an installation of a special eductor at the filtration plant of Danville, Va. (Malcolm Pirnie, Engr.) which operates on high pressure water to supply the full flow of wash-water required from the plants clear-well. Likewise, at Baltimore arrangements are being made to use similar eductors for dewatering shafts and water tunnels. Thus we see the possibility of other permissible and practical uses for eductors in water works operation—one being their application to increase the capacity of pumps suffering from high suction lift troubles.



The Albe Suction Booster

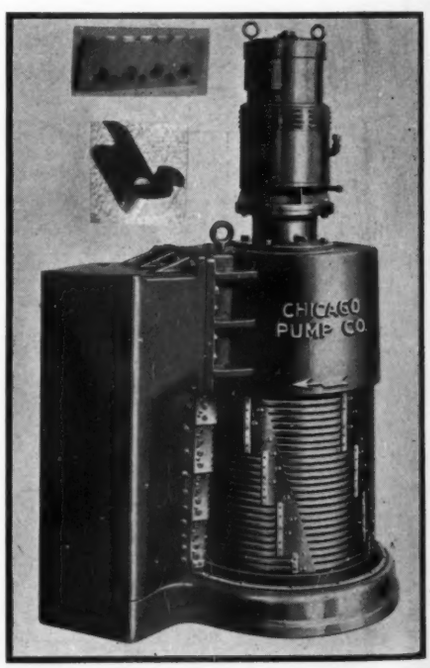
The boosting ejector here pictured is manufactured by the Albe Pump Corp., 8-26 Berry Street, Brooklyn, N. Y. Those (much larger) at Danville, Va. and Baltimore, Md. were supplied by Schutte and Koerting of Philadelphia. For further particulars write one or both companies.

▼

Comminutor Now Has Haynes-Stellite Teeth and Plates

The success and economy in operation of the submerged-drum type sewage screenings comminutor, manufactured by Chicago Pump Company, hinges on the sustained sharpness of the stationary cutting-combs (plates attached to the spine of the machine at left of the drum) and the shearing teeth, shown staggered on the drum face. (See insets of both in the upper left of cut).

Information has come from Haynes



Chicago Comminutor

Stellite Company, New York City, that Chicago Pump Company, after thoroughly testing the merits of various alloys and steels for the combs and teeth, have adopted Haynes Stellite. It is one of the hardest of the cobalt-chromium-tungsten steel alloys and is effectively resistant to wear by corrosion as well as abrasion. Although one of the more costly alloys, so much depends upon the maintenance of sharp combs and teeth that the search for the best, when analyzed, represents an overall economy measure. The above cut pictures one of the new type Stellite toothed, (2 M. G. D.) Chicago Comminutors—others have capacities as low as 200,000 G. P. D. and as high as 70 M. G. D.

If you are interested in the Comminutor, for further details write Chicago Pump Co., 2336 Wolfram St., Chicago. If interested in corrosion and wear resisting alloys for welded facings on metal parts, or for solid parts, write Haynes Stellite Co., 205 East 42nd St., New York City.

▼

New Colony Counter

Spencer Lens Co., of Buffalo, N. Y., have announced a new illuminating bacteria counter known as the Quebec Colony Counter—because of its development in the Quebec Provincial Health Department Laboratories by Dr. M. H. McCrady and co-workers Archambault and Curot.

Advantages claimed for the improved counter are the following: (1) Light passes through the agar and colonies obliquely, to show up effectively and prominently the deep as well as shallow imbedded colonies; (2) The counter can be used in any desired position in respect to plate angle in counting, most comfortable to the user; (3) Magnification is such as to prevent eye strain anywhere on the plate; (4) It was especially designed to

Quebec Colony Counter

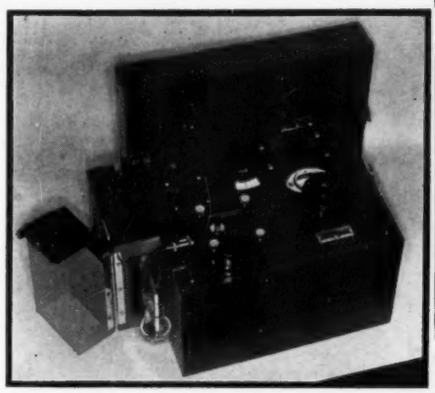
attain accuracy and ease in picking off colonies; (5) Oblique illumination also enhances visibility of the counter plate lines to make for ease in counting.

A descriptive circular of the Quebec Counter with price list may be had by writing Spencer Lens Co., Buffalo, N. Y.

New, Universal pH Indicator by L & N

cut in Chicago ... ...

The "Universal pH Indicator" of Leeds and Northrup Co., shown for the first time at the last Chemical Exposition, is a versatile instrument. It reads directly in pH with Glass, Quinhydrone, Hydrogen or any other electrode. When used with the glass electrode system, furnished, simply setting the dial of the temperature compensator adapts the entire pH scale to measurements at that temperature. This applies also if a quinhydrone electrode is substituted for the glass electrode. Equipped with a voltage scale as well as a pH scale, it is also used in oxidation-reduction potential measurements, and in current flow and resistance determinations.



Universal pH Indicator

The newly-designed glass electrode is small, comparatively rugged, and requires only a 5 ml sample for measurement. Everything necessary for glass electrode measurements is included with the instrument. Of traditional L. & N. qualities, it is compactly built, readily portable and is warranted to operate for years at full sensitvity and accuracy. For further information ask for Catalog E-96 (1); address Leeds and Northrup Co., 4934 Stenton Ave., Philadelphia.

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WITH THE MANUFACTURERS

Canariis Joins Pomona Pump

Svend A. Canariis, until recently special Waterworks Engineer for Westinghouse Electric & Mfg. Co., has been appointed Waterworks Engineer for the Pomona Pump Co., of Pomona, Calif.

Svend A. Canariis

Mr. Canariis was born and educated in Denmark. Prior to his engagement with Westinghouse he was Electrical Engineer for the Pittsburgh Water Department during which time he was responsible for several money saving betterments, including central-station and automatic operation. He is a member of the American Water Works Association, the American Institute of Electrical Engineers, and the Society of American Military Engineers.

His work with Pomona Pump Co. will, for the present, consist of special application engineering in the eastern states and in foreign countries. In his new position, Mr. Canariis will make his headquarters Pittsburgh, Pa.

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Higgins of Pittsburgh Equitable Honored

When the Texas Arts and Industries College introduced its Natural Gas Engineering Course, Captain A. E. Higgins, Vice President of Pittsburgh Equitable Meter Company, then Secretary of the Natural Gas Association, was asked to serve as chairman of a committee to plan the course of study. In recognition of his work and the success attending the course in Natural Gas Engineering, the College recently conferred upon Captain Higgins an hnoorary degree and presented him with its Golden Key, as a symbol of appreciation.

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Robinson Resigns

Announcement has come from M. P. Robinson, for the past 17 years Eastern representative for International Filter Company of Chicago, with offices at 150 Nassau St., of his resignation. Mr. Robinson expects to remain in the water and sewage field, but for the immediate present expects to take a vacation while making plans for the future.

COPPERAS
(FERROUS SULPHATE)
··· FOR WATER & SEWAGE TREATMENT
(The Base For Chlorinated Copperas)

ALGAE CONTROL

Copper Sulphate has long been recommended by leading water works engineers, when slime, scum or other effects of algae and undesirable microorganisms give trouble. Easiest algicide to use, no special equipment or training required.

WE INVITE YOUR INQUIRIES

FAESY & BESTHOFF, INC.
22 E. 40th St. New York

Pomona offers the Unidrive Head designed specifically to apply power for pumps. Only Pomona provides a non-reversing ratchet in the pump head, which positively prevents damage from shaft rotating backward. Accessible packing gland above the ground avoids expensive repairs which are inevitable if this part is at the bottom of the drive shaft. Positive lubrication is provided by the water which is being pumped. Only Pomona provides full-floating rubber bearings operating in stainless bearing surfaces. Column pipe, like all other parts, is interchangeable and fully standardized. Open-bottom bronze impellers, operating in streamlined, pocketless bowls are adjustable for water capacity and wear.

POMONA PUMP CO.

Manufacturing Plants: Pomona, Calif. — St. Louis, Mo.
Branch Offices: New York, Chicago, Los Angeles, San Francisco

POMONA
Water-Lubricated
TURBINE PUMPS

MEETINGS SCHEDULED:

Aug. 17-19—WHEELING, W. VA. (Hotel Windsor).
Central States Section, A. W. W. A. Sec'y, E. P. Johnson, 418 Flannery Bldg., Sta. 13, Pittsburgh, Pa.

Aug. 25-26—LEXINGTON, VA. (Hotel Robert E. Lee).
Virginia Section, A. W. W. A. Sec'y, H. W. Snidow, State Dept. of Health, Richmond, Va.

Sept. 15—LEBANON, PA.
Pennsylvania Water Works Operators' Assn. Sec'y-Treas., I. M. Glace, 22 South 22nd street, Harrisburg, Pa.

Sept. 12-13—CASPER, WYOMING (Townsend Hotel).
Rocky Mountain Section, A. W. W. A. Sec'y, B. V. Howe State Office Bldg., Denver, Colo.

Sept. 13-16—BOSTON, MASS. (Hotel Statler).
New England Water Works Association. (57th Annual Convention). Sec'y Frank J. Gifford, 613 Statler Bldg., Boston, Mass.

Sept. 13-15—COLLEGE PARK, MD. (University of Maryland).
Short Course for Operators of Water & Sewage Treatment Plants. Chairman, Short Course Committee, Carl A. Hechmer, Hyattsville, Md.

Sept. 14-16—SAGINAW, MICH. (Bancroft Hotel).
Michigan Section, A. W. W. A. Sec'y, M. N. Gerardy, Water Board Bldg., Detroit, Mich.
(Meeting Jointly with)
Sept. 14-16—**Michigan Conference Water Purification.** (Annual Convention). Sec'y-Treas., R. J. Faust, Michigan Dept. Health, Lansing, Mich.

Sept. 19-20—WATERTOWN, S. DAK.
South Dakota Water & Sewage Works Conference. Sec'y W. W. Towne, Board of Health, Pierre, S. Dak.

Sept. 22-23—POUGHKEEPSIE, N. Y. (Nelson House).
New York Section, A. W. W. A. Sec'y, R. K. Blanchard, 50 West 50th street, New York City.

Sept. 26-27—MINOT, N. DAK. (Hotel Leeland Parker).
North Dakota Water & Sewage Works Conference. Sec'y-Treas., M. D. Hollis, Bureau of Sanitary Engineering, Bismarck, N. Dak.

Sept. 27-28—COLUMBUS, OHIO (Fort Hayes Hotel).
Ohio Conference on Water Purification. Sec'y, Thos. R. Lathrop, State Dept. of Health, Columbus, Ohio.

Sept. 29-30—COLUMBUS, OHIO (Fort Hayes Hotel).
Ohio Conference Sewage Treatment. Sec'y, B. M. McDill, Dept. of Health, Columbus, Ohio.

Sept. 29-Oct. 1—MINNEAPOLIS, MINN. (Hotel Nicollet).
Minnesota Section, A. W. W. A. Sec'y, R. M. Finch, 416 Flour Exchange, Minneapolis, Minn.

Oct. 2-5—NEW YORK CITY, N. Y. (Hotel Pennsylvania).
American Public Works Association (Congress). Executive-Director, Frank W. Herring, 1313 East 60th street, Chicago, Ill.

Oct. 6-7—WASHINGTON, D. C. (Hotel Raleigh).
Four States Section, A. W. W. A. Sec'y, Carl A. Hechmer, Dept. Engr., Washington Suburban San. Distr., Hyattsville, Md.

Oct. 6-8—HARTFORD, CONN. (Bond Hotel).
New York State Sewage Works Association. Sec'y, A. S. Bedell, State Board of Health, Albany, N. Y.
(Meeting jointly with)
Oct. 6-8—**New England Sewage Works Association.** Sec'y, F. W. Gilcreas, State Dept. of Health, Albany, N. Y.

Oct. 10-12—MILWAUKEE, WISC. (Hotel Plankinton).
Wisconsin Section, A. W. W. A. Sec'y, Al A. Smith, City Hall, Madison, Wisc.

Oct. 12-14—ROCHESTER, N. Y.
American Society Civil Engineers. Sec'y, Geo. T. Seabury, 33 West 39th St., New York City.

Oct. 13-14—NEENAH-MENASHA, WISC.
Central States Sewage Works Association. Sec'y-Treas., W. H. Wisely, State Dept. of Health, Springfield, Ill.

Oct. 13-15—MORGANTOWN, W. VA.
West Virginia Conference on Water Purification. Sec'y, J. B. Harrington, Division of Sanitary Engineering, Charleston, W. Va.

Oct. 13-15—DES MOINES, IOWA (Hotel Fort Des Moines).
Missouri Valley Section, A. W. W. A. Sec'y, Earl L. Waterman, University of Iowa, Iowa City, Iowa.

Oct. 17-20—OKLAHOMA CITY, OKLA. (Hotel Biltmore).
Southwest Section, A. W. W. A. Sec'y, L. A. Quigley. Supt. City Water Works, Fort Worth, Texas.

Oct. 19-21—ATLANTIC CITY, N. J. (Hotel Haddon Hall).
Pennsylvania Water Works Assn. Sec'y, Dr. F. Herbert Snow, 327 Telegraph Bldg., Harrisburg, Pa.

CATALOGS AND LITERATURE RECEIVED

[Any of the publications reviewed in this section can be secured from or through Water Works and Sewerage, if such be desirable.]

"The ARTGEL Processes"—Are described in a brochure from Devonshire-Artic Chemical Co. of Boston. "Hydro-Artgel" is the trade name of the inhibited acid offered by this company for disintegrating and removing rust-scale, hard scale, or tuberculation, from water pipes and mains (in place), as described in an article, "Experiences in Water Main Cleaning," elsewhere in this issue. In the brochure the "Artgel Method" of removing scale and encrustation from Diesel engines, water supply pipes and services on interior piping, without damage to the metal, is described. It lists the equipment required and tabulates estimated costs for "Hydro-Artgel" reagent required per foot for chemical cleaning pipes of various diameters by the "Artgel-Surge System." Also the effectiveness of cleaning tubular steam condensers with "Hydro-Artgel" is told by testimonial. For this brochure, and allied literature on water conditioning in steam generation, or for cooling systems, write Devonshire-Artic Chemical Company, 201 Devonshire Street, Boston, Mass.

"Transite Sewer Pipe"—Is a new Johns-Manville brochure, which gives rather complete information on the adaptability and economy of the light-weight asbestos-cement "Transite" sewer pipe. Five distinctive reasons for Transite pipe in sewer construction are set forth, and pictures of typical installations are numerous. Two chapters are devoted to a discussion of lower costs of installation, maintenance and treatment, which result when Transite pipe is used. The compound sealed sleeve-type joint (for gravity lines), which is root and infiltration tight, and the rubber ring compression type Simplex coupling (for pumping mains) are described and their installation pictured. Stressed is the fewness of joints with the 13 ft. pipe lengths. Information is also given on the simple methods of making house connections (now or later), at any spot desired, with a hammer and chisel cut. Also covered are other installation considerations, such as high flow capacity coefficients and resistance to corrosive sewages or sewer gases. For a copy of "Transite Sewer Pipe" (form TR-21A) write Johns-Manville Corp., 22 East 40th St., New York City.

"OMEGA Feeders"—Is a brand new, and complete, catalog from Omega Machine Company of Kansas City. It illustrates and describes the full line of Omega machines for measuring and feeding dry and liquid materials in water and sewage treatment plants. In addition are included the Omega Laboratory Stirrer and Dust Removal Equipment. New sections cover the Improved Omega Lime Slaker, with a list of important installations, and the Omega Disc Feeder for dry chemicals. Other items are the Precision Solution Feeders (gravity and pressure types); Gravametric Feeders (batch and belt types); The Weighcheck Feeder; and, the best known of them all, the Omega Universal Feeder. At the end are condensed and easy to compare specifications, with tabulated data on each type of feeder. An innovation is the printing of prices of each type of equipment for various capacities. For the new Omega catalog, write Omega Machine Co., 4010 Penn Ave., Kansas City, Mo.

Saved:

(at Fort Smith, Arkansas)

11% of Water Treatment Costs

FERRISUL has been chosen as the coagulant at Fort Smith, Arkansas, because (in the words of the Water Department's annual report) "it seemed to be the most effective and the most economical". Chemical costs per million gallons were reduced from $2.576 to $2.289 in the first month that Ferrisul was used.

> "... the raw Lake Fort Smith water", says the report, "is both very soft and of a low natural alkalinity and has, therefore, an excessive tendency to be corrosive. Realizing that the pH and alkalinity of the water had to be increased in order to protect our mains and services from this corrosive tendency we carried on a series of studies of various treating methods which would permit us to increase the pH and coagulate the turbidity in one operation. . . . We finally settled on the use of Ferrisul (Ferric Sulfate) as our coagulant both because it seemed to be the most effective and the most economical."

This is only one of many problems that Ferrisul can solve. If you are not entirely satisfied with the costs or the performance of your present coagulant, ask your consulting engineer about Ferrisul, or write direct to us. Monsanto Chemical Company, Merrimac Division, Everett Station, Boston, Mass.

Ferrisul

(anhydrous ferric sulfate)

FOR WATER AND SEWAGE TREATMENT

EASILY—ECONOMICALLY

P.Q. SILICATE in the treatment of water supplies produces a larger floc more rapidly. Plants operating with P.Q. Silicates report quicker settling with consequent increased filter capacity and clearer filter effluent.

If your capacity is lagging behind demand, investigate P.Q. Silicate of Soda. P.Q. Silicates are made by a company in business over a century.

PHILADELPHIA QUARTZ COMPANY
General Offices and Laboratory: 125 S. Third St., Phila., Pa.
Chicago Sales Office: 205 W. Wacker Drive. Stocks in 60 cities.
Sold in Canada by NATIONAL SILICATES LTD., Toronto, Ont.

PQ SILICATE OF SODA

Accurate and Dependable

Infilco Type CD Rate of Flow Controllers have no extra gadgets to get out of order; no stuffing boxes, pivoted levers or cumbersome counterweights. Sensitive to even the most slight fluctuations in head.

Operating rates are controlled simply by turning a knob on the front of the rate setter. The design is simple and sensible. Designed to meet the demands of the most exacting water works engineers.

Write for Bulletin 500

INTERNATIONAL FILTER CO.
59 E. Van Buren Street, Chicago

"Sludge Drying and Incineration"—Is the new "Dorrco" bulletin devoted to The C. E. Raymond System of sludge drying, to produce fertilizer, or to be burned in the incinerating (second) stage at will. The five steps from wet sludge to ash, vapor and dust collection are succinctly set forth by use of line drawings emphasized with color to accompany photographed installations. The Raymond System is unique for its flexibility in that any desired quantity of the pre-dried (granulated) sludge may be disposed of as fertilizer base to produce revenues, or may be burned as fuel, as the case may warrant. The equipment and its operation at Neenah-Menasha is described as a typical installation. The largest is that at Chicago's West Side Works. The C. E. Raymond System is designed and manufactured by the Combustion Engineering Company, which has assigned exclusive world-wide marketing rights to The Dorr Company. For a copy of Bul. No. 6781 address The Dorr Co., 570 Lexington Ave., New York City, or any branch office in America or abroad.

"The Clarigester" — Is the subject of another "Dorrco" bulletin. The "Clarigester" (as new as its name) constitutes an economical structure for providing clarification and separate sludge digestion, in a single two-story unit. The circular tank provides a shallow upper and deep lower compartment. On a center vertical shaft rotates two mechanisms. From the clarification chamber (operated as a center-feed unit) the sludge is continuously forced to the center. Here it drops through a gas-trapped opening into the lower (digestion) chamber. To the shaft extending through the floor of the clarifier (roof of the digester) is affixed the sludge stirring and scum breaking mechanism in the lower compartment. The "Clarigester" has been developed especially for small communities of 1,000 to 5,000 population, as an essentially complete separate digestion plant, for the least structural cost. For a copy of Bulletin 6681-C which effectively illustrates and describes the "Clarigester," and provides design data and operating results, write The Dorr Company, 570 Lexington Ave., New York City.

"Successful Experiences"—Is the cover title on a Cutler-Hammer bulletin, which sets forth successful experiences with "C-H" electrically operated and controlled valves and gates in numerous water works and sewage treatment plants and pumping stations. Amongst these is America's largest electrically operated and centrally controlled pumping station, that of Pittsburgh, Pa. An important sewage plant "C.H." equipped is Cleveland's Westerly Plant. "C.-H." operated valves are pictured from the smallest (4-in.) to a 72-in. gate valve employed to provide remote or automatic control and positive action without delay. "C.-H." valve control stations, contactor panels, multi-point float switches, motor control accessories, and safety and pressure switches, are all briefly described and illustrated. For a copy of enlightening "Successful Experiences," write Cutler-Hammer, Inc., Milwaukee, Wis.

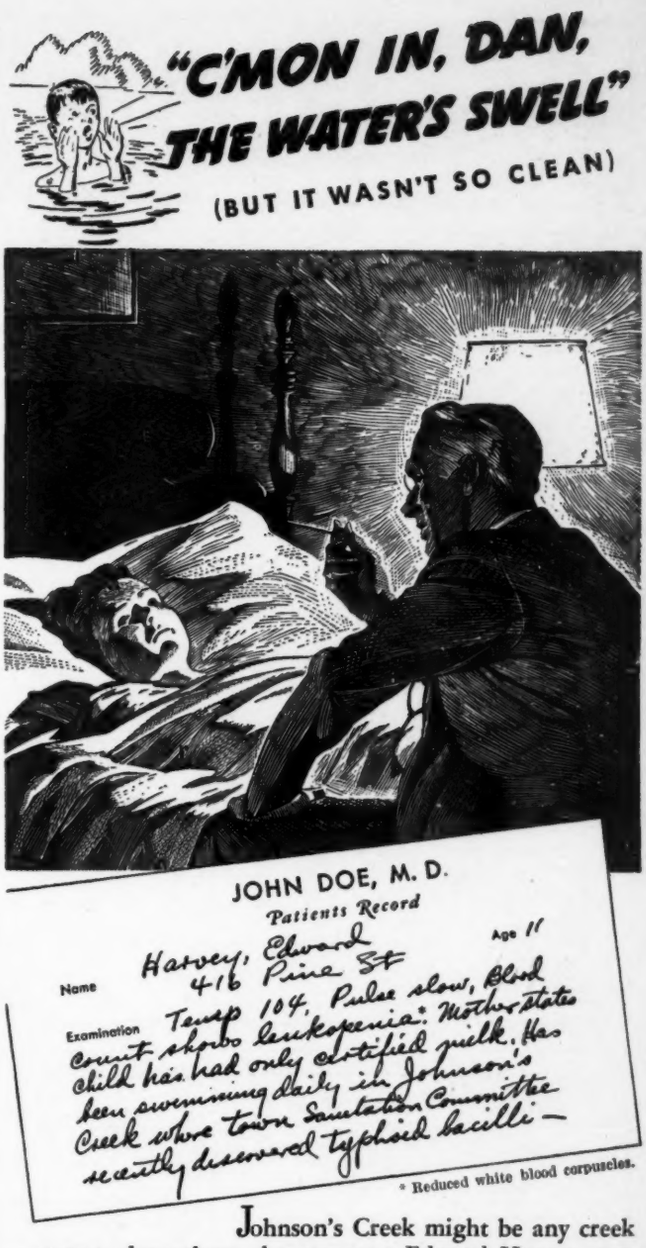
"Jeffrey Shredders"—Is a new catalog devoted to the Swing Hammer Shredders of Jeffrey Manufacturing Co. It pictures many typical installations of Jeffrey Shredders in a variety of industrial shredding or pulping operations, from sugar cane to garbage and sewage screenings. Various types of Jeffrey Shredders and their component parts are described and illustrated. The so-called "hammers" are in reality swinging cutting blades of heavy construction. For a copy of Catalog 660, write Jeffrey Mfg. Co., Columbus, Ohio.

"PYREX Catalog"—Fresh from the press comes the new Corning Glass Works catalog of the full line of "PYREX" brand laboratory glass-ware and equipment. This catalog is the most comprehensive that Corning has produced. It contains 128 pages, and carries 2,353 individual items, of which over 700 are listed for the first time. Some of the features of the new equipment are that practically all ground joints, stoppers and stopcocks listed are now interchangeable. The number of pieces per package have been reduced on many items, and prices are reduced on more than 500 items. For a copy of the impressively complete "PYREX" Laboratory Catalog LP-18, write Corning Glass Works, Corning, N. Y.

"Chlorination Topics"—Which came from Wallace and Tiernan Co., made its bow with the No. 1 issue for July. As its cover title implies, the new publication presents news items and topics of interest concerning chlorination developments. The featured story in the first issue describes Cleveland's new 14-ton chlorinator installation for providing pre- and final chlorination at the new Easterly Activated Sludge Plant of 230 M.G.D. capacity. A battery of 6 W. & T. Automatic Master Chlorinators of 4,000 lbs./day capacity each (24,000 lbs./day) constitutes the pre-chlorination and return sludge chlorination station. Two automatic 2,000-lb. machines provide effluent chlorination. The last page is devoted to brief abstracts under caption "Current Literature Review." If you are not already on the W. & T. mailing list, "Chlorination Topics," as a newsy publication, is worth requesting of Wallace and Tiernan Co., Newark, N. J.

"Checking-Up on Check Valves"—Is the catchy and significant caption of a new 8-page booklet, in two colors, from Crane Company of Chicago. In word, picture and diagram it gives the reader the real "low-down" on check valve design, their performance and care. The two basic types of checks (swing and lift) are described, and their various applications discussed. Then there are presented 10 "Do's and Don't's to Keep in Mind." And follows two pages of cut-away illustrations of various types and patterns of checks, showing approved materials of construction. Finally, "When and Where to Use What Type and Design" of check is discussed; also, where *not* to use check valves at all. Aside from its mission as a "Handy Reference Guide to Crane Check Valves," this booklet is virtually a text on check-valves and their uses. For a copy of snappy "Checking Up on Check Valves," write Crane Company, 836 So. Michigan Ave., Chicago, Ill.

"Ford Hoists and Trolleys"—Are described and illustrated in a new and complete catalog by the Ford Chain Block Div. of American Chain and Cable Co., pioneering manufacturers of hand hoists. Featured is the new Spur-geared FORD Tribloc, which now has the load-sheave running on ball-bearings—a recent improvement. A phantom view of the Tribloc hoist reveals why the chain can be guaranteed against creep, under any load. Other Ford hoists are the screw and the differential types. Several additional Ford items have been added, amongst these being Trolley Hoists, Winch and Jib Cranes and a Differential Hoist with ball-bearings. Prices are quoted for complete units and also on replacement parts. For Catalog 38, write Ford Chain Block Div., American Chain and Cable Co., 2nd and Diamond Streets, Philadelphia, Pa.


"C'MON IN, DAN, THE WATER'S SWELL"
(BUT IT WASN'T SO CLEAN)
JOHN DOE, M. D.
Patients Record
Name Harvey, Edward Age 11
416 Pine St
Examination Temp 104, Pulse slow, Blood count shows leukopenia. Mother states child has had only certified milk. Has been swimming daily in Johnson's Creek where town Sanitation Committee recently discovered typhoid bacilli—
* Reduced white blood corpuscles.

Johnson's Creek might be any creek or stream throughout the country—Edward Harvey, any American boy . . .

Pollution of streams by sewage (and some insufficiently purified effluent from plants) is fast becoming a major problem. *Be doubly certain!* Purify all effluent from disposal plants with Solvay Liquid Chlorine!

Immediate shipments of Solvay Liquid Chlorine are available in cylinders or tank cars for swimming pools, sewage and water purification plants.

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Water Works — Sewerage
Utilities

Baltimore, Md. — **Albany, N. Y.**

IMPORTANT

The September Issue of WATER WORKS & SEWERAGE —advertising forms—will close in Chicago September 6, 1938.

Arrangements are being made to distribute copies of this issue at 13 different conventions—from September 12th to October 13th, 1938. Most prominent of these are the New England Water Works Association Meeting in Boston, and the Joint New York and New England Sewerage Meeting in Hartford, Conn.

Why not arrange to schedule your advertisement in this outstanding issue?

The Publishers.

Water Control Equipment

You will be interested in the complete line offered by MUELLER. Write for catalogs of the equipment in which you are interested.

MUELLER CO. . . Decatur, Ill.

Factories: Decatur, Ill.; Chattanooga, Tenn.; Los Angeles, Calif.; Sarnia, Ont.

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Use P F T Equipment in Your Sewage Treatment Plant

Write for Latest Bulletins

PACIFIC FLUSH TANK COMPANY

Designers & Manufacturers of Sewerage and Sewage Treatment Equipment

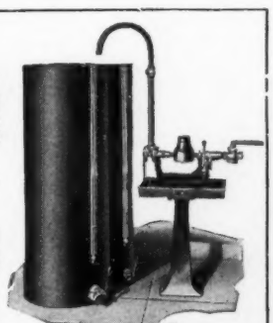
4241 Ravenswood Ave. Chicago, Ill.

EXCLUSIVELY SINCE 1893

441 Lexington Ave. New York, N. Y.

The FORD METER TESTER for WATER METERS

Accurate, convenient and moderate in cost. Hundreds in use. Machines are made for testing one to five meters and calibrated tanks are made in three sizes. Write for information and prices.



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WABASH, INDIANA, U.S.A.

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30 YEARS EXPERIENCE

WRITE FOR OUR BOOKLET

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50 CHURCH ST. NEW YORK

CAN WE HELP YOU?

Do you want latest literature and catalogs?

Do you want additional help or information on contemplated purchases?

WATER WORKS & SEWERAGE readers are invited to take full advantage of our "Readers Service Department" which will assist you, without cost or obligation, in obtaining catalogs, literature, etc., or any other information you desire.

Use convenient blank below.

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WATER WORKS & SEWERAGE,

155 East 44th Street, New York, N. Y.

Please send me without obligation literature, or information on following:

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August

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STOP ROOT Rings

U. S. PAT. No. 1,968,734

ROOT-PROOF SEWERS GUARANTEED!!!

Inexpensive Installed in clay or concrete pipe without tools or special equipment. Joints are made in the regular way. Available in all sizes through Plumbers, Sewer Contractors, Building Supply Dealers, Plumbing Jobbers and Sewer Pipe Manufacturers.

WRITE for free and complete data for your files.

Sample Ring on request.

A-B-C MFG. CO. 205 S. 4th St. **Quincy, Illinois**

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"STANDARD OF QUALITY"

For more than thirty years we have specialized in the art of water purification. We manufacture a full line of water filters, both pressure and gravity type; Zeolite water softeners; swimming pool recirculating equipment; and various forms of water rectification units. Inquiries are invited on all problems of water treatment.

ROBERTS FILTER MANUFACTURING CO.

607 COLUMBIA AVE. DARBY, PA.

SPARLING

MAIN-LINE METERS

Thousands are in service in water works, irrigation, oil fields, railroads, paper mills and many other industries.

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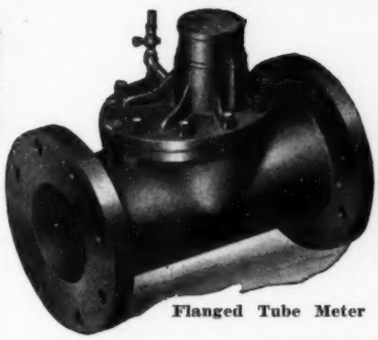

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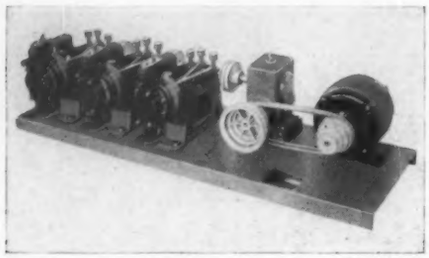

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D

Darco Corp. 742
Dorr Company, The ..... Third Cover
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E

Eastern Gas & Fuel Asso. 798-799
Edson Corporation, The 815
Electro Bleaching Gas Co. ..... —
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F

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Farnan Brass Works Co. ..... —
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Ford Meter Box Co. 813
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H

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Hill Associates, Nicholas S. 812
*Hill, Hubbell & Co. ..... —
*Hudson Coal Co. ..... —
Hydrauger Corp., Ltd. ..... —

I

*Industrial Chemical Sales 773
*Inertol Company, Inc. ..... —
*International Filter Co. 810

J

*Johns-Manville 741-797

K

Knowles, Inc., Morris 812
Koppers Coal Co. 798-799
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L

Layne & Bowler, Inc. ..... —
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Lynchburg Foundry Company ..... —

M

M & H Valve & Fittings Co. ..... —
Mabbs Hydraulic Packing Co. 815
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*Mathieson Alkali Works, Inc., The . 748
Merrimac Division 809
Metcalf & Eddy 812
Modern Iron Works ..... —
Monsanto Chemical Company 809
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National Lumber & Creosoting Co. 798-799
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O

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*Omega Machine Co. ..... —

P

Pacific Flush Tank Co. 813
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Permutit Company ..... —
*Philadelphia Quartz Co. 810
Pirnie, Malcolm 812
*Pittsburgh-Des Moines Steel Co. .... —
Pittsburgh-Equitable Meter Co. ..... Front Cover
Pomona Pump Co. 808
Potter, Alexander 812
Portland Cement Assn. ..... —
*Proportioneers, Inc. 816

R

Reilly Tar & Chemical Corp. 750
Rensselaer Valve Co. ..... —
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S

Salomon & Bro., L. A. ..... —
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T

Tar & Chemical Div. of Koppers Co. 798-799
Test Plug Mfg. Co. ..... —
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U

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V

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W

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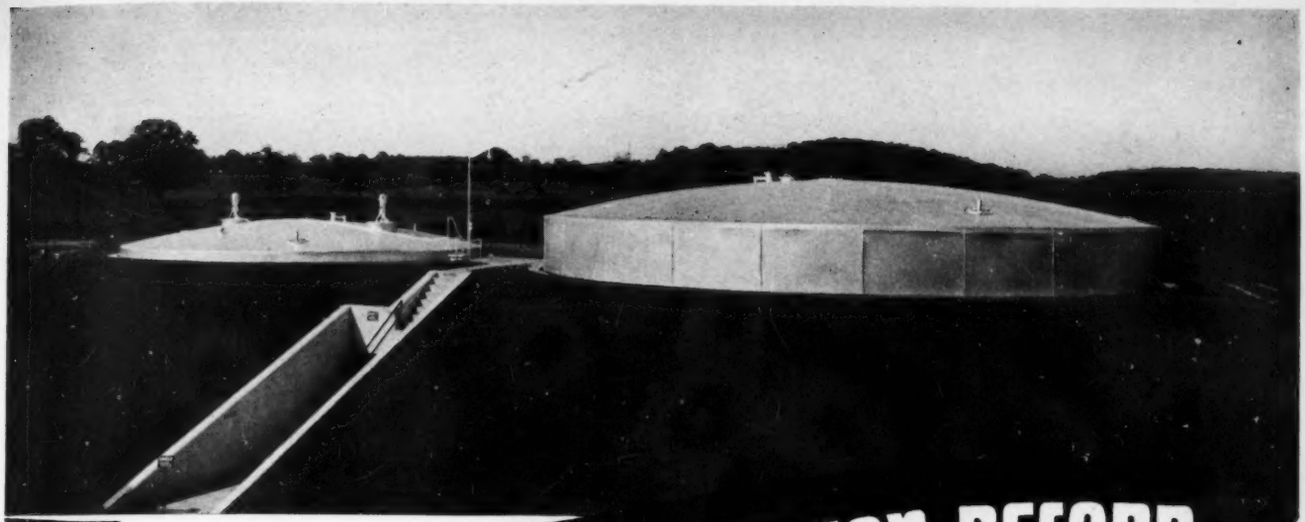

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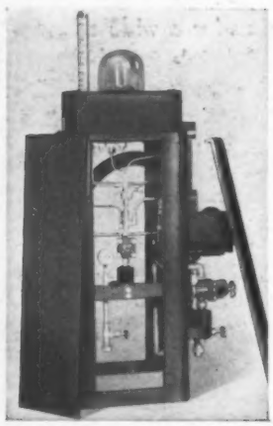

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